ISOCARP
REVIEW 14

CLIMATE CHANGE PLANNING

ISOCARP

The International Society of City and Regional Planners (ISOCARP) is a global association of experienced professional planners. It was founded in 1965 in a bid to bring together recognised and highly-qualified planners in an international network. The ISOCARP network brings together individual and institutional members from more than 80 countries worldwide. As a non-governmental organisation ISOCARP is recognized by the UN, UNHCS and the Council of Europe. The Society also has a formal consultative status with UNESCO. The wealth and diversity of professional expertise, knowledge, and experience in the ISOCARP membership is unmatched in the planning field.

Although ISOCARP members work in many different fields they share a common interest in the spatial and environmental dimensions of urbanisation. They advise key decision-makers, proposing and supporting projects for intervention in a spatial context through general or specific actions.

The objectives of ISOCARP include the improvement of planning practice through the creation of a global and active network of practitioners. ISOCARP encourages the exchange of professional knowledge between planners, promotes the planning profession in all its forms, stimulates and improves planning research, training and education and enhances public awareness and understanding of major planning issues at a global level.

The association's main event is the annual **ISOCARP Congress**, which focuses on a globally-significant planning theme and which takes place in a different country each year. Since 1965 ISOCARP congresses have taken place in all parts of the world on cutting edge topics and have always promoted knowledge creation and sharing in the planning profession.

Prior to the congress **Young Planning Professional** Workshops are organized. This YPP programme seeks to bring together emerging young planning professionals from all over the world to tackle 'real-world' planning projects.

All ISOCARP activities are covered in **publications** such as the ISOCARP Review, the International Manual of Planning Practice (IMPP), Congress proceedings and special project reports.

ISOCARP recognises excellence through the Society's **Awards programme**.

ISOCARP **Urban Planning Advisory Teams** (UPATs) assists sponsor organizations by offering the extensive experience and expertise of ISOCARP members to work on important local or international planning projects, programs and policy initiatives.

In response to specific requests for ISOCARP assistance with research and consulting services, ISOCARP forms **Technical Assistance Teams** consisting of members who volunteer their expertise and experience. In 2016 ISOCARP officially established the **Institute** as a "**Centre of Urban Excellence**" and formal body for generating, documenting and disseminating knowledge for better cities.

The Institute's core function is to design and deliver capacity building and continuing education programs; conduct research and promote knowledge transfer; as well as offer advice and short-term consultancy services to government, non-government and international bodies worldwide.

ISOCARP Head Office
International Society of City and Regional Planners
Gaby Kurth, Programme Manager
Monica Ornek, Office Manager

Laan van Meerdervoort 70
2517 AN The Hague, The Netherlands
Phone: + 31-70 346-2654
isocarp@isocarp.org
www.isocarp.org

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ISOCARP
Knowledge for Better Cities

Review 14

Editors
Editor-in-Chief: Małgorzata Hanzl, ISOCARP VP, Poland
Editor: Jim Reilly, United States
Assistant Editor: Mahak Agrawal, India

Coordinator
Lucian Perici, Romania

Graphic Designer
Ricardo Moura, Portugal

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ISOCARP PRESIDENT'S FOREWORD

RIC STEPHENS
ISOCARP PRESIDENT 2015-2018

COOL PLANNING: CHANGING CLIMATE AND OUR URBAN FUTURE

The defining issue of our time is anthropogenic, global, climate change. The sustainable equilibrium elements of environment, economy, and society are all at risk from climate change impacts. Global warming is creating ecosystem tectonic shifts, disrupting energy and resource economies, and spawning authoritarian geopolitics. Even as our glaciers are disappearing, the response to climate change is moving at a glacial pace. Previously moderate projections for future temperature are now the predicted levels. If mitigation measures are not implemented, severe adaptation measure will be. What does this mean for city and regional planning? We must incorporate three approaches to balance long-term, short-term, and aspirational planning: sustainable development, urban resiliency, and regenerative design.

SUSTAINABLE DEVELOPMENT

Intergenerational equity provides a foundation for urbanism that requires environmental stewardship, economic development, and social equity. Sustainable development is at the heart of planning. ISOCARP represented professional planning at the Habitat III conference, and the Society is a leader in advocating and implementing the global, *Sustainable Development Goals*. These goals include Climate Action, and ISOCARP is a founding member of the UN-Habitat Planners for Climate Action.

URBAN RESILIENCY

The long-range vision of sustainability must be complemented by consideration for contemporary disaster preparedness and risk reduction. Climate change, population growth and displacement, and fiscal instability all contribute to more frequent and severe disasters. To counter these issues, the Society is a member of the Global Alliance for Urban Crises and affiliated with the United Nations International Strategy for Disaster Reduction. ISOCARP member projects and programs must apply urban resiliency principles in their design and implementation.

REGENERATIVE DESIGN

Sustainability indicates the need for climate change mitigation, and resilience the need for adaptation. Both approaches emphasize continuity. The third approach considers aspirational visioning that transcends 'continuity.' It answers the questions "Where do we want to go?" and "Who do we want to be?" Regenerative design encompasses values and aspirations beyond anthropocentric definitions of sustainability and the immediacy of disaster responsiveness. It is a vital role for ISOCARP and its members to help identify and guide sense of place and community, rational planning and systems thinking, and both macro- and micro-scale visioning.

Although the challenges are great, and the stakes are high, the potential for a transformative urbanism is the clear alternative to the current path. There is friction to the changes required to realize these approaches: institutional barriers, social displacement, xenophobia, and, many others. Despite these obstacles, transformative planning will ultimately create communities which are healthier and more vibrant. These changes will be guided by planning practice and technologies.

PLANNING PRACTICE

ISOCARP's mission is "Knowledge for better Cities," and the Society has developed a wide array of activities and media to achieve this goal: advisory services, awards, congresses and events, consultancy projects, databases, global networks, publications, social media, technical assistance, and, more.

The Society programs implement sustainable development, urban resiliency and regenerative design goals. They are designed to provide value to members, partners, and the international community. The *Review* is our premier publication, and I thank the authors, editors and contributors for combining their insights and skills to create an extraordinary resource for community planning.

TECHNOLOGIES

Review 14 includes the Society's white paper on smart cities. Smart urbanism is inevitable, and it will merge information and communications technologies, energy, resource and infrastructure technologies into networks that create sustainable, resilient, regenerative, urban-rural ecosystems containing vibrant communities with thriving economies and biodiverse environments. Bodø aspires to be the 'world's smartest city,' and is already a phenomenal model of sustainable development, urban resiliency, and regenerative design. I am deeply grateful to the hosts and organizers of this year's Congress for their energy and enthusiasm to ensure the Congress is both meaningful and memorable.

EDITORS' FOREWORD

Once again it is our privilege to welcome you to the ISOCARP Review. This year most of our articles focus on the topic of "Cool Planning: Changing Climate and Urban Future". We are pleased to publish nine articles about how planning can mitigate, and assist cities to adapt to, climate change, while three more articles report engineering and scientific efforts to develop new climate change planning tools. We then present three plans that are noteworthy and have elements related to climate issues and sustainability.

New to Review 14 are a book review section and a revised format to the Congress Local Area Committee (LOC) foreword. This year we invited Bodo to tell us about themselves – their history, their demographic and employment make-up, their life style and their recent and on-going planning efforts- to inform our Congress attendees about their host town. They provided a fascinating document which we hope the Review readers enjoy and find useful. We also thank the Bodo LOC for providing the photos used throughout this publication.

Again, the Review has been designed as a digital and printed publication. We have organized our articles into 6 sections as shown in the Table of Contents (TOC): Welcome to Review 14; Plans to Mitigate and Adapt to Climate Change; Climate Change Planning Tools; Noteworthy City and Regional Plans; ISOCARP Activities, and Book Review. Please use the TOC as your gateway to the articles. From there, in the digital version, you can hyperlink to any section or to any article. You can return to the TOC from any page by clicking on the "TOC" found at the bottom right corner of any page.

Our section on "Plans to Mitigate and Adapt to Climate Change" includes articles from six different countries and the scale of the plans ranges from the mega-city scale of the Paris Metropolitan Region to intimate ones in New Zealand and Australia. Of our two articles from Canada, one presents a plan to adapt Vancouver's urban forest to both development and climate change induced rising temperatures. The second Canadian article describes a plan to mitigate climate change impacts to the Fraser River watershed and insure the supply of fish, critical to the Indigenous culture of that area. We have two articles from India and both focus on climate adaption of houses. One also explores ways to improve the disaster resilience of informal housing. Our article from South Africa demonstrates how collaboration with other cities resulted in improved sustainability planning. We close this section with a more general discussion of the need to implement "green and blue" concepts into urban plans.

We are very pleased to include three articles about climate adaption research and the planning tools being developed by these projects. We learn about the meticulous climate modeling and the testing of heat sink remediation efforts in Vienna. Another article tells how Norway is working to develop zero emission buildings. Finally, we have a wonderful article explaining how the European Commission- Joint Research Center scientists have improved remote sensing capabilities and how they are using this information to identify areas which are prone to climate change related damage.

As is our mandate, we also include noteworthy city and regional planning projects. In our first article, we learn about detailed plans to develop two "Blue and Green" projects, a sustainable mixed-use technology center and a regional park, in the Chinese mega-city of Wuhan. Next is a discussion about developing sustainable, climate change adapted urban areas to be built north of the Artic Circle. Lastly, we present a description of a long-term effort collaborative effort, recently begun, to restore the cultural landscape along the Yamuna River as it makes its way through the National Capital Territory of Delhi, India.

Our last section contains the Society White Paper about the marriage of Smart and sustainable growth.

As usual, all the credit for the wonderful articles presented in this publication belong solely to the authors and their teams of professionals who produced the plans. The Review staff thanks them for their hard work preparing their drafts, their perseverance enduring our editing, their good spirit while providing us with illustrations suitable for publication, and their dedication to producing the highest quality article for the enjoyment of the worldwide planning community.

BODØ: THE ARCTIC CITY OF OPPORTUNITIES

FIGURE 1: Night view over Bodø. Photo by Per-Inge Johnsen, Bodø Municipality

What is it about our city in the far north that makes it so special? The location of the city affords natural wonders not seen elsewhere. Our seas are rich with fish. Our location is well suited for transhipment of goods and people. As a result, Bodø has experienced a fairy-tale development in recent years. The city centre is being transformed, many new building projects are under way and a new city hall is being built. The recently completed Stormen (*The Storm*) concert venue and library are wonderful buildings that form the beating heart of the city centre. The city's inhabitants are proud of their city and full of optimism for the future.

Together, we hope to build the world's smartest city. We see Bodø as a city where the needs of people are at the forefront.

FIGURE 2: Position of Bodø in Europe

SOME FACTS ABOUT OUR CITY

Bodø is located in the far north of the beautiful country of Norway. It lies immediately beyond the Arctic Circle in the heart of the County of Nordland. It has a population of 52,000 and covers an area of 1,395 km². The municipality extends a distance of 60km from east to west and 70km from north to south.

Fisheries form the basis for growth and development in both historic and modern Norway. Ever since the Viking age, the coast of Norway has survived by selling fish, particularly cod, to buyers from across Europe. It would not have been possible to survive along the coast of Norway without cod. The trading centre of Bodø was granted city status in 1816 so that it could control, transport and sell fish to Bergen and to buyers from across Europe. The city was founded at Hundholmen Plass, now situated in the centre of modern-day Bodø. In 1904, the large breakwater in Bodø was built to protect the port from waves and bad weather. Just inside the breakwater, facing the port basin is the pleasure craft harbour and piers for fishing vessels. Construction of the breakwater marked the start of the modern development of the city of Bodø.

World War Two changed the physical character of the city. Bodø city centre was completely destroyed by Luftwaffe bombing on 27 May 1940. Of the city's 760 houses, 420 were destroyed in the Nazi attack. Fifteen people died during the bombing and sixty percent of the population, or around 4,000 people, were left homeless. Only a few of houses remained in Bodø city centre. The city's cathedral and city hall were also bombed and were rebuilt during the period 1956-59. Svenskbyen (the Swedish Town) is part of the city that was given as a gift from Sweden during the war years to redress the housing shortage in Bodø. This house district has now been awarded protected status.

Today the architecture of the city is predominantly post-war. Much of the city centre was developed in the 1950s and 1960s. Many of the building façades were given protected status under a cultural heritage plan in 2006. Work has been under way for a number of years on a plan to protect and develop parts of Storgata (The Main Street). This plan was adopted by the city council in March 2018. The area covered by the plan has been designated as being worthy of preservation nationally for its collection of post-war buildings. The plan state that the entire street is to be designated a pedestrian zone. The roadway will be developed into a pedestrian zone and an urban space for play areas, parks and activities.

The Glasshuset pedestrian street was built in 1992 and is a glass-covered part of the public street of Storgata in the centre of Bodø. The Glasshuset is open 24 hours a day all year round and is important for both trade and the attractiveness of the city centre.

About 28,000 people work at non-military jobs in Bodø. Unemployment is extremely low at approximately 2%. While public administration and service provision is vital for employment in the municipality and accounts for around 40% of jobs, Bodø has a wide variety of industries.

Bodø's militarily strategic location was a key factor behind the presence of the Norwegian Armed Forces in Bodø. Bodø has been the most important operational fighter base in Norway since the 1950s. The present joint civilian/military airport was built hurriedly in 1952. The fighter base in Bodø will finally move away from the city in 2022, although the Norwegian Armed Forces will continue to maintain a strong presence, because it will have its operational headquarters in Bodø.

Bodø is a central transport hub in Northern Norway. The terminus of the rail network is here. The infilling of Rønvikleira and the dredging of the bay in the late 1970s gave the port a new basin and provided the city with new, large and valuable industrial plots.

We have a busy port, where the famous 'Hurtigruten' (coastal cruise) calls on its way both north and south every day throughout the year. Marine industries represent a mainstay and include marine aquaculture, the processing of fish products, fish landing and the supply industry. The city is 'situated in the heart of one of the world's most important food baskets'. The offshore seas are one of the most productive nurseries for cod, in particular, and other marine species. The County of Nordland produces a quarter of Norway's farmed salmon and other fish.

The airport is Norway's fourth largest measured in terms of the number of flights and it is the sixth largest measured in terms of passenger numbers. A flight from Oslo to Bodø takes about 90 minutes.

The retail sector has traditionally played an important role in Bodø and is the largest employer in the private sector, with over 3,500 employees. Transport and logistics are also important with 2,500 employees, confirming Bodø's vital role as a transport hub. Other important industries include building and construction, services and tourism.

There are also many jobs in education, research and public services in marine industries. There is a great effort to create more jobs in the region.

WHAT IS IT LIKE TO LIVE IN BODØ?

THE CITY WITH THE MOST HOURS OF DAYLIGHT PER YEAR

Bodø and its environs have more hours of daylight per year than anywhere else in the world. Although Bodø is situated north of the Arctic Circle and experiences the Midnight Sun during the summer, there is no polar night in the winter due to the angle of the Earth's axis. Instead of darkness, we experience what is called the "magical light" (sunlight reflected off of the atmosphere) and the Northern Lights (light created by energised ions in the atmosphere) throughout the winter. Many tourists come to Bodø to experience this winter light show.

There are equal amounts of light and dark around the time of the spring equinox on 21 March. In summer we enjoy the midnight sun between 4 June and 8 July.

WHAT ARE OUR SEASONS LIKE?

The seasons are intense, and they affect the daily lives of everyone. The weather can vary considerably during the winter, with snow one day, rain the next, and then back to snow again the following day.

Spring in the north is a short and intense period. Nature stirs from its winter hibernation and deciduous trees spring into leaf once again. Migratory birds return from the south and bring teeming life to the area.

Summer is a time of light, but the weather is very unpredictable, ranging from sunshine and warmth to rain and storms from the west.

Autumn often arrives at the end of August with darker evenings and falling temperatures. The autumn brings out beautiful colours in nature. Rainfall is typically high in October and November in Bodø. The first snowfalls also arrive around this time.

Climate

Bodø is a coastal city with a typical Norwegian coastal climate, with an annual mean temperature of 5°C. The seasons are intense and the weather is always on people's minds.
July has a mean temperature of 16ºC and the coldest time is in February, when temperatures drop to-1ºC. The wettest month is October with average precipitation of 94.3mm. Bodø is 'renowned' for always being windy. The wind often comes from the east in both summer and winter. Winds from the west originating over the sea often bring heavy precipitation.

FIGURE 3: The breakwater pier (Moloen) in the city centre is popular for recreation in all types of weather

WHAT DO WE DO IN THE WINTER?

Life continues as 'normal' during the winter. The unpredictable weather often presents challenges in the form of ice and snow on the roads and streets. During icy conditions roads and pavements must be gritted to make them safe for driving and walking. But the winter snow provides wonderful opportunities for skiing, sledging and playing out in the great outdoors.

The climate means that buildings and infrastructure must be insulated in such a way that water cannot freeze and that enables houses to be kept warm. Norway has a plentiful supply of hydroelectric power and good access to electricity, and it is common for buildings to be heated using electricity. The climate also means everyone has to wear clothes, which are suitable for the cold and precipitation. It is entirely normal for all pre-school and schoolchildren to play outside every day in all weathers. Many people enjoy the changeable weather and love to be outside and experience the forces of nature.

FIGURE 4: ↑Pedestrian street in winter
FIGURE 5: ↓The city in the middle of the nature

ENJOYMENT OF NATURE

In Norway, one can hike and camp anywhere in the countryside. No matter who owns the land, the public has the right to access on all uncultivated land. It is extremely popular to go hiking in the woods, along the coast and in the mountains. In Bodø, land close to urban areas has been protected from development. Bodømarka is a very popular recreational area where many people enjoy cross-country and alpine skiing and hiking throughout the year. Many paths have been created throughout Bodømarka (see Figure 8).

SPORTS FACILITIES IN BODØ

Bodø has many excellent sports facilities to offer. The largest arena, Bodø Spektrum, is located close to the city centre and is home to an indoor football pitch (soccer), handball courts and swimming pool. The indoor football hall means football can be played all-year round. A recreation park for cross-country skiing known as Bestemorenga is situated just outside the city in Bodømarka, and in winter, many kilometres of ski trails are prepared for everyone to use. Many of the ski trails are also lit.

HISTORIC CHURCHES

The oldest church in Bodø was built in 1240. The Medieval church of ***Bodin kirke*** is the oldest building in Bodø. The cathedral, "Bodø domkirke", in the city centre was burned down in 1940 when the city was bombed. The new church was then built, being completed in 1956. It was given protection in 2002. ***Bodø domkirke*** is part of Bodø's post-war architecture.

EDUCATION – SCHOOLS

Nord University is located at Mørkved, 8km east of the centre of Bodø. The university has 6,000 students in Bodø (and 12,000 students at various study locations across the region). A division of the Norwegian Police University College is also located at Mørkved. There are two large upper secondary schools in the municipality, as well as many primary and secondary schools spread across the various districts of the city. The municipal authority has found maintaining sufficient school capacity challenging because the population and number of children is increasing. Several new schools are now being built.

FIGURE 6: ↑ Recreation under the midnight sun
FIGURE 7: ↓ Inner city of Bodø

PLANNING HISTORY AND KEY PLANNING MEASURES

Bodø is in the middle of an extremely exciting period with many large urban development projects. Urban development is about creating a city where people thrive. Planning, predictability and participation are key elements to achieve good urban development. We want a land use policy for Bodø that involves the building of a compact city with green development throughout the municipality. Bodø city centre has developed and changed considerably over the past four years and will change even more over the next four years.

The new municipal master plan for land-use for Bodø will be adopted by the city council in June 2018.

URBAN PLANNING IN BODØ

Many organisations contribute to the positive urban development in Bodø, including both public authorities and industry in Bodø in particular.

Byplan (Urban Planning Office) is an office in the Technical Division, which has 15 employees. The staff of Byplan collectively possesses considerable expertise in land use planning and make up an excellent planning environment. A wide variety of urban development expertise is brought together in one place.

Byplan is responsible for the municipal authority's land use planning. The office is responsible for preparing most of the municipality's master plans, which set out the framework for the use and protection of land throughout the municipality. *Byplan* is also responsible for submitting private land use plans for approval. We are also involved in many development projects together with other stakeholders in the municipality, other authorities and industry.

Our task is to prepare the municipality's management tools for land use. The framework for urban development is established through the municipal master plan of land-use, which is adopted by the city council. This stipulates where housing, commercial buildings, schools and roads can be built and, in particular, areas that cannot be developed. The plan must safeguard natural resources for the agricultural industry and reindeer husbandry and protect our beautiful landscape. The proposed plan focuses on development across the municipality.

Another task over the past 12 months has been to update the municipal master plan of land-use. Many residents have expressed their views regarding the proposed plan. Public meetings have been held throughout the municipality, and meetings and exhibitions have been held in Stormen. The new municipal land use plan sets out the framework for the future development of the city centre and new development projects.

SOME FOCUS AREAS OF THE MUNICIPAL MASTER PLAN FOR THE PERIOD 2018-2030:

A new plan for marine areas has been created which sets out in more detail the areas that may be used for aquaculture and areas that have been allocated for other interests, such as fishing and recreation.

The master plan has a marked focus on strong land preservation and protection of the basis for the reindeer husbandry. A new masterplan for parks and public space will ensure attractive residential environments and recreation areas. The parks will facilitate activity and varied use. The extensive natural areas will be protected from development.

The municipality of Bodø traditionally updates the municipal master plan of land-use approximately every four years. With regard to the city centre development as it stands today, the plans dating from 2006 and 2008 (*Nerbyen-planen*) have strongly influenced developments in the city centre. Descriptions of some of the key planning measures which have had a positive effect on urban development are described below.

URBAN DEVELOPMENT AREA

In the urban development area, which covers the area from Mørkved – Sentrum – Løpsmark and Tverlandet centre, a compact city is being built, which includes areas for housing development. Eighty five percent of the municipality's population, or around 44,000 people, live in the urban development area. This means that Bodø already has compact urban development. Over the coming years, the aim is to develop the vacant areas inside the urban development area for housing and essential social infrastructure, such as school and nurseries. The municipality will meet its needs for housing development by using these planned areas. Around 400 new houses will be needed every year. The municipal authority has just adopted a new Housing Plan, which sets out how the targets for ordinary housing will be met and how the municipality will work to develop social housing.

PLANNING MEASURE – NEW HOUSING DEVELOPMENT IN THE HEART OF THE CITY CENTRE

The municipal master plan of land-use, adopted in June 2014, opened the possibility of new housing development in the heart of the city centre. It was previously considered that such central areas should be reserved for commercial activity. However, a strong desire has gradually emerged to make the centre of Bodø more attractive and to bring more people into the city centre. A key planning measure was to enable residential development in the heart of the city centre and to focus on developing an attractive city centre.

The many construction cranes in the city today demonstrate the huge benefi-

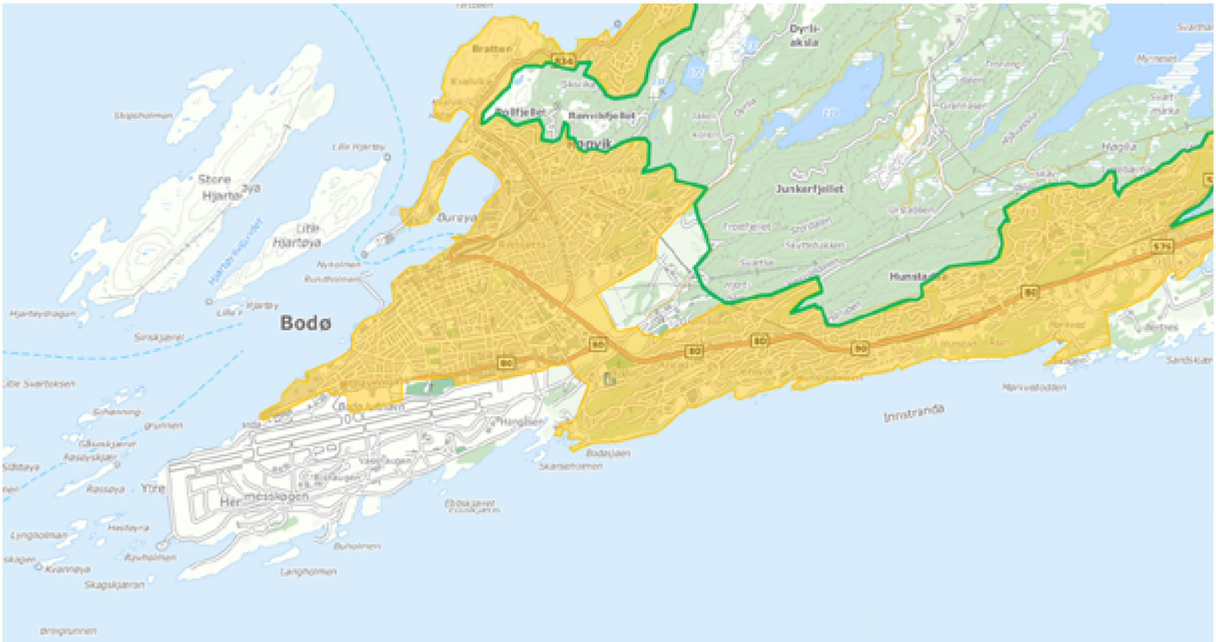


FIGURE 8: The urban development area (yellow area) and the border (green line) to the main recreation area, Bodømarka

cial implications of this decision. The commercial sector in the city has seized this potential in an extremely positive way. A “new” city is being built in the centre of Bodø. The decision in the municipal land use plan from 2014 relating to residential development has led to several new housing projects. This will double the number of residential units in the inner city, and most of the apartments will be ready for occupation during 2018-2020. In the development plans, the municipal authority also imposes a requirement that the ground floor at street level must be made available for activities aimed at the public, such as retail businesses, eateries, and services. This will provide the city centre with many new business areas and services, as well as other functions that make the areas at street level both active and geared to ensuring that people spend time there.

PLANNING MEASURE – FOCUS ON CULTURE

The focus on the development of Stormen cultural block has been vital in creating an attractive city centre. The decision to focus on culture, during a challenging economic period around 2005, was the result of a bold political decision. The location of a new concert hall and new library was approved in 2008 in a development plan called ***Nerbyen-planen***. This plan contains several major projects which are now nearing completion. The plan includes provisions to build four high-rise buildings ranging between 14 and 17 stories in the city centre.

FIGURE 9: Increased building activity in the city centre

Stormen cultural block has been built on the two remaining undeveloped plots in the city following the bombing in 1940. The buildings were completed in November 2014 and the opening ceremony was broadcast on national TV. New pedestrian streets have also been established around the buildings, and the quay in front of the library has been improved to create a wonderful new urban space.

Stormen has been a fairy-tale success. The city's inhabitants have started using the buildings and visitor numbers are much higher than anticipated. The architecture has attracted considerable attention in the international press. Stormen won a national architectural award in 2015 and the justification for the award stated:

> *"Stormen library and concert hall is a unique, beautiful and carefully considered example of architecture at the highest international level. The two buildings follow the existing street structure, interact with the other buildings, and landscape in a way that enriches the entire centre of Bodø. The architect and client have together created an outstanding model for good architecture."*

DRDH Architects was the architect for the buildings and Dark Arkitekter AS was the architect for the external spaces.

FIGURE 10: Stormen library and concert hall

NEW CITY HALL

Like the rest of Bodø, the old City Hall was bombed and burned down on 27 May 1940. A new city hall was built in 1959 and is a good example of modernistic revival architecture. The City Hall was granted façade protection in the cultural heritage plan of 2006. The City Hall gradually became outdated and ceased to meet the needs of the present day in terms of ventilation and working environment. There was also a need to bring together the administration of the municipality under one roof. An architecture competition was launched in 2013 to develop a new city hall.

The Danish architectural firm Atelier Lorentzen & Langkilde won the 'New Bodø City Hall' competition with its draft 'A crossover between city & citizens, past and future' (*Et krysningsfelt mellom by & borger, fortid & fremtid*) in January 2014.

The new city hall will have space for 400 office workstations and a total floor area of around 11,000m^2. The building complex will comprise a new building, which will be built where the former library wing once stood. The existing City Hall and the building known as 'Banken' will also be completely refurbished. The new building will link all buildings together to form a single unit.

The new City Hall will serve as an office building for the administration of the municipality of Bodø and will also meet any requirements regarding essential functions for political work, with offices and meeting rooms for the political parties and city council representatives.

FIGURE 11: The new town hall will open in 2019

The existing city council chamber, executive committee chamber, staircase, and stairwell will be preserved. The City Hall will be completed in April 2019 and is expected to be occupied before the summer. The City Hall is situated in the centre of Bodø and will generate considerable activity in the city centre thanks to its 400 jobs.

The parks located to the west of the City Hall will be upgraded to take on the form of entirely new parks, which will be used both by local residents and to host major events.

NEW CITY – NEW AIRPORT

The decision to relocate the existing airport is a national strategic decision aimed at promoting growth and generating economic growth from the perspective of the north.

There is a unique opportunity to plan, build and develop a new, smart, compact and environmentally friendly city of the future in the north – as a direct expansion of the existing city centre. There is also a unique opportunity to build a smart and environmentally friendly national airport that will serve one of the country's fastest-growing regions for future growth and development.

This unique opportunity has arisen because the present runway built in 1952 must be replaced, and, for safety reasons, the new runway cannot be built on the existing site.

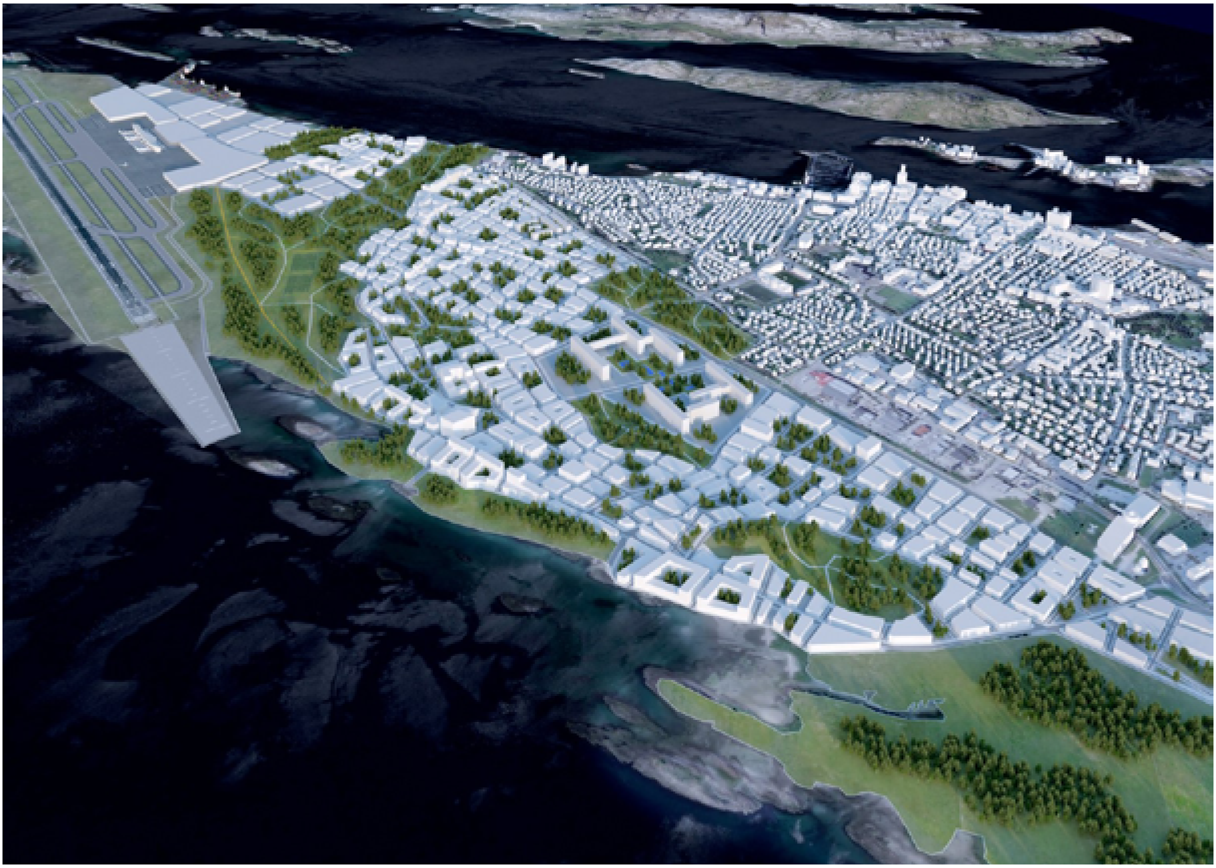


FIGURE 12: The relocation of the airport in 2024-2026 will provide big opportunities for future development of Bodø

Stortinget (the Norwegian Parliament) has also decided that Bodø Main Air Station (*Bodø Hovedflystasjon*) is to close after operating for more than 60 years as a fighter base. This presents an opportunity to construct the new airport further away from the city and to release valuable areas in the city centre for urban and port development over a 50- to 100-year perspective. The sales revenue also offers considerable benefit for both the State and the local community.

Not only is the new airport a transport investment which will be beneficial to society as regards the growth and development of the Bodø and Salten regions, Nordland and the region as a whole, it is also a fundamental investment in the future development of the new Bodø.

A long-term airport solution for civil aviation in the Bodø and Salten regions is a national transport project, an urban and regional development project and a climate and environmental project.

Once this enormous land area has been released, it will open up the potential to try out and develop new methods for urban development and smart technological solutions in energy-efficiency, transport and the environment. It presents a unique opportunity to bring together road, rail, and sea and air transport in the same area at the heart of one of the largest cities north of the Arctic Circle.

The Storting decided to construct a completely new civil airport to the south-west of the existing airport in June 2017. This decision triggered extensive planning activities among all the stakeholders involved.

Bodø municipality's city planning office is now drawing up a land use development plan for a new civil airport in partnership with Avinor (State-own company that owns and runs national airports). The goal is for the city council to adopt the plan in June 2019. The airport is then scheduled to open during the period 2024-2026.

The municipal authority has also begun work on the latest urban development project in Bodø: Planning a new district on the site of the present airport. The urban development area released covers an area of around 3 million square metres. The area will meet the municipality's housing needs up until 2065 and possibly beyond. The chance to plan a completely new city represents a very special opportunity. The goal is to plan for smart and environmentally friendly urban development with a long-term perspective. New and smart transport and energy solutions will present major challenges. The aim is for the initial development stage to be a zero-emission district.

NORWAY'S MOST ATTRACTIVE CITY

Bodø was voted 'Norway's most attractive city' in 2016. A desire to focus on city centre development and the 'New City – New Airport' (*Ny by – ny flyplass*) project were crucial in the jury's selection of the winner.

> *"Bodø sees opportunities where others see limitations," said former Minister of Local Government and Modernisation, Jan Tore Sanner.*

The jury for the State prize for the most attractive city particularly emphasised the following:

> *"There are two elements that led to Bodø being awarded the prize. The first is excellent city centre development. The second is the project* "New city – new airport"*. This is where Bodø has demonstrated that it is able to turn what is essentially a problem, i.e. the closure of the military part of the airport, into a resource for the city."*

The jury also emphasised:

"Bodø has experienced strong population growth, growth which has been addressed in an excellent manner. City centre development has been prioritised in municipal planning over a number of years, an approach that produced results. Housing has been built in the city centre and this is one of the most important measures that cities and urban areas can implement. The importance of encouraging more people to live in the heart of the urban areas is something that can scarcely be overestimated.

Realisation of Stormen cultural block, with its library, theatre, concert hall and 'house of literature', has changed the role of the city centre. It has made the core of the city more interesting and dynamic and had a positive impact on visitor numbers, cultural life and the consumption of culture. It has also led to a marked increase in city centre trade.

In the "New City – New Airport" project, Bodø has created an urban development project that is capable of channelling growth in the right direction, which means that urban and industrial development can go hand-in-hand. Bodø's strong population growth in recent years has been accompanied by a strong focus on the city centre, which has generated pride among the city's residents. This pride is a wonderful resource, which means that increasing numbers of people are looking to live and work in Bodø.

We would also like to emphasise that the excellent development that Bodø is undergoing cannot be taken for granted and further strong and sustainable growth requires the adoption of a distinct urban policy. This means that the "New City – New Airport" project should focus not only on ecological sustainability, but also on social and economic sustainability. This will also enable the municipal authority to govern through a predictable land use policy that is in line with the overarching national guidelines concerning land use, housing and transport policy. Most importantly, the ambitions regarding architecture in the private sector should be at the same level as the architecture where the public authorities have been the client."

FIGURE 12: Kids playing at the main square.

PARTICIPATION

As head of city planning, I am determined that our planning processes will be open and predictable and involve good dialogue. We hold meetings concerning new land use plans and many people come to meet us and express their views.

The municipality of Bodø opened a Citylab (Bylab) in Stormen library in April 2018. Bylab offers a meeting place for everyone who is seeking information, and for the citizens to express views on urban development in Bodø.

Bylab Bodø is a place where the residents of Bodø and other stakeholders can put forward proposals and suggestions as to how Bodø can be a better city in which to live in future. The residents of Bodø are the city's real experts as users of the city every single day and we want these people to become more involved in the development process than they are at present.

OPTIMISM

Why have we been so successful in transforming the city and our focus on city centre development?

The community of Bodø is characterised by great optimism and residents are proud of the city. This is not something that can be taken for granted. Some years ago, it was commonplace to describe the city as boring, ugly and grey, and a place where nothing happens. What has happened in recent years to completely transform this view of the city?

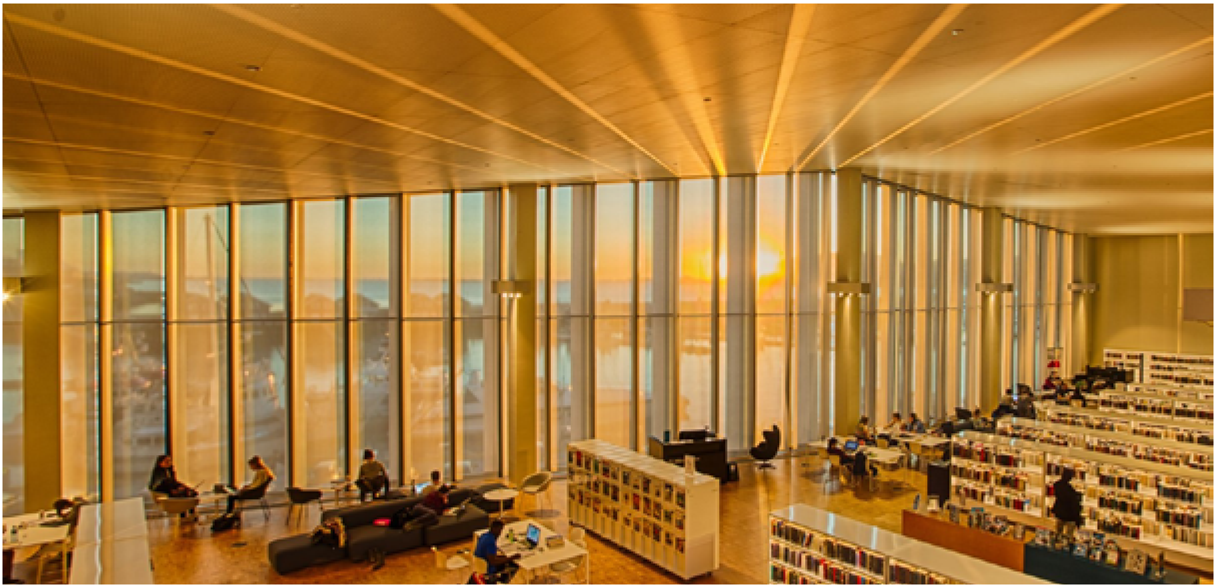


FIGURE 13: The Bylab is located in Stormen library

The world has come to Bodø in many ways. Stormen cultural district and the New City – New Airport project combined with the creation of an attractive city centre has led to a different view and perception of the small city of Bodø in the far north, where the wind is always blowing from the north/south/west/east. Suddenly, everyone is aware of their city and loves it for what it is. The focus on culture, with the Stormen and Parken festivals and the Nordland Music Festival, has created a sense of belonging to the city for many people and a sense of pride that so many people have stood together at the big events in the city. The transformation of the city centre and strong belief in the future characterises the city, and almost everyone is now facing the future with great faith and a big smile.

People come to Bodø from all over the world to experience the Midnight Sun, the Northern Lights, nature and the culture. Bodø needs young people skilled in many disciplines and we are thrilled to welcome newcomers.

I welcome everyone to our city north of the Arctic Circle and the 54th ISOCARP Congress. I look forward to meeting so many planners from all over the world, and during the congress week, would like to show our city, our nature and how we live. It is very exciting that so many have delivered abstracts to the congress and that there is so much international and national interest in coming to our beautiful city in the north. I warmly welcome all of you!

Annelise Bolland, Head of the Urban Planning Office, Bodø Municipality

ANNELISE BOLLAND (the author) has been the Head of the Urban Planning Office in Bodø Municipality since 2011. She has a background in environmental and agricultural sciences

PLANS TO MITIGATE AND ADAPT TO CLIMATE CHANGE

↑↑ TOC

PARIS/ILE-DE-FRANCE REGION FACING CLIMATE CHANGE

ERIC HUYBRECHTS

FIGURE 1 : Snapshot from the 3D video simulation Flooding Paris.
SOURCE : IAU îdF

INTRODUCTION

One of the major goal of the Paris/Ile-de-France Region is to prevent the effects of climate change. To achieve this goal there are two main responses: mitigation with a focus on the reduction of greenhouse gas emission; and, adaptation with a focus on risk management and prevention. These responses have had direct effects on the way the Paris/Ile-de-France 2030 regional master plan was prepared and designed. We have identified that flooding, storms and heat waves are the main risks facing the region and we are exploring solutions to manage these crises. Solutions exists that require large scale actions and a high level of coordination making them difficult to implement in a metropolitan area.

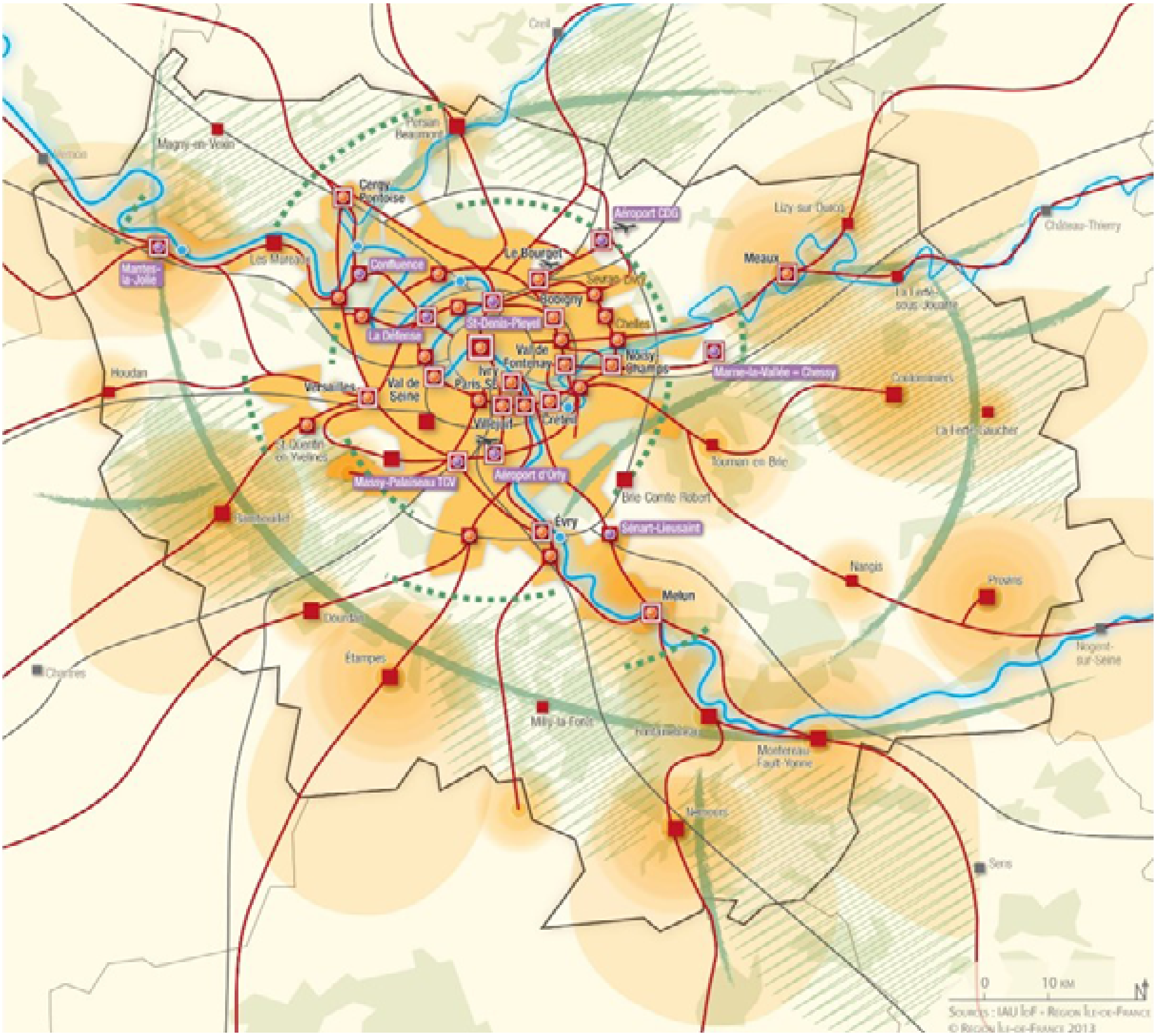


FIGURE 2: Paris/Ile-de-France Regional spatial strategy

PARIS/ILE-DE-FRANCE 2030 REGIONAL MASTER PLAN: A TOOL SHAPED FOR CLIMATE CHANGE MITIGATION AND ADAPTATION

The Grenelle de l'Environnement, a main French legislative reform adopted during the beginning of this century, makes ecological transition a major objective of urban planning documents. Additionally, the Paris Agreement for Climate change was a key moment for the international community to define strategic objectives regarding climate change challenges. The recent environmental awareness initiatives by public authorities and citizens make it a political issue, but, in fact, the Paris region has been working on this topic for decades.

Several documents have been adopted regarding climate change: the Ile-de-France Regional Climate Plan; the Regional Air, Energy and Climate Scheme; and, the "Ile-de-France 2030" Regional Master Plan (SDRIF adopted in 2013). These planning documents have been drawn-up to respond to the level of vulnerability already observed and the results of climatological, socio-demographic, and urban forecasting. The Ile-de-France 2030 regional master plan defines the spatial strategy for the development of the global metropolis. Prepared in a collaborative manner, it represents a contemporary answer to tackle climate change issue at the scale of a large metropolis.

The socio-economic development of the Île-de-France has a strong impact on its energy requirements, a key factor for greenhouse gas emissions. Ile-de-France, which hosts 19% of the France population and 30% of the National GDP, represents only 15% of the national energy consumption. The expansion of the service sector, which consumes less energy than industry, and the density of the urban fabric explains much of the relative advantage of the Paris/Ile-de-France region in terms of energy and greenhouse gases emissions. Despite this configuration, the emissions of greenhouse gases in the Paris region continue to rise, even though a stabilisation has been observed at a national level. To reduce mobility needs, and then greenhouse gases emissions, the regional master plan focuses on a compact, dense and multi-polar region. It includes policies and spatial development strategies to develop urban spaces adapted to renewed mobility, with less dependency on the automobile, and to boost new sources of renewable energy. The mobility requirement forced rethinking by developing alternative modes of transport (cycling, walking, public transportation, shared cars…).

The inner suburbs, characterised by a dense urban fabric, and the outer suburbs benefit from improving access to public transit and active modes of transport. The Greater Paris Express metro line project - 205 km long with 68 new stations in the suburbs is one of the larger urban project in the world – also connects dense and diverse neighbourhoods around the stations using alternative mobility modes (public transport, bicycle paths, traffic calming of motorised vehicles on boulevards…). This key project is intended to renew the urban fabric, increase job and housing opportunities inside the existing urban areas, and reduce the need of suburban extensions. To make it possible, the plan identifies and defines specific regulations to encourage urban intensity in the existing urban fabric, especially within the 2 km surrounding of the main metro and railway stations, creates new green and transportation connections, and sets minimum densities for the urban extensions.

Also, the development of a circular economy is encouraged to reduce the mo-

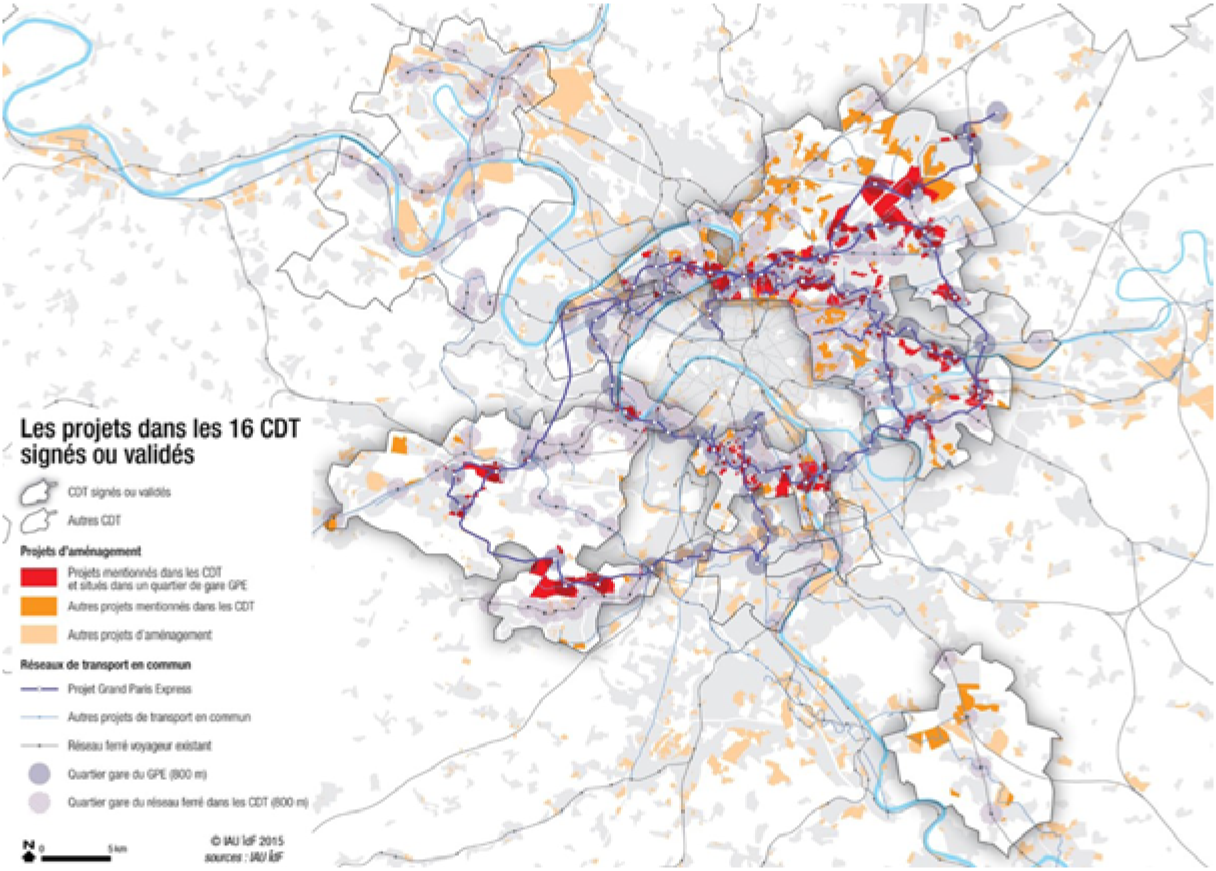
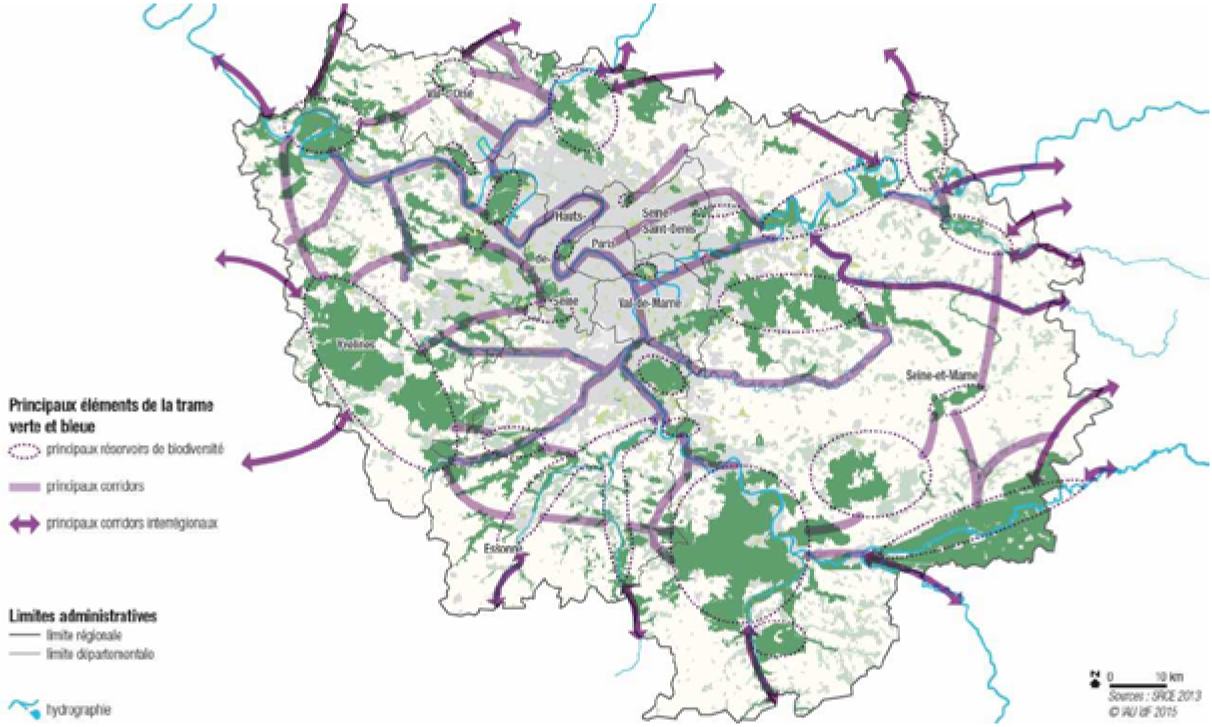


FIGURE 3: Greater Paris Express, a strong infrastructure to reshape the metropolis through large urban projects around metro stations

bility of goods. Also redeployment of the logistic multimodal platforms is promoted to take into consideration the effect of the smart systems on commercial delivery. Priority is assigned to rail-river-road intermodal transport services.

The priority given to public transport aims to reduce the consumption of fossil fuels, and the urban densification facilitates the use of geothermal heating. Moreover, the regional master plan encourages localized networks to supply energy by allocating land for urban service facilities (oil depots, associated liquid hydrocarbon pipes, storage and natural gas pipelines, strategic lines for very high voltage electric transport network, etc.). These reservations for equipment avoids their rejection in the outskirts, which if allowed to happen would increase consumption of space and require more transport. Furthermore, the necessary rights of way have been reserved for the deployment of equipment to link local renewable energy production and recovery, as well as their distribution, particularly through heat networks.



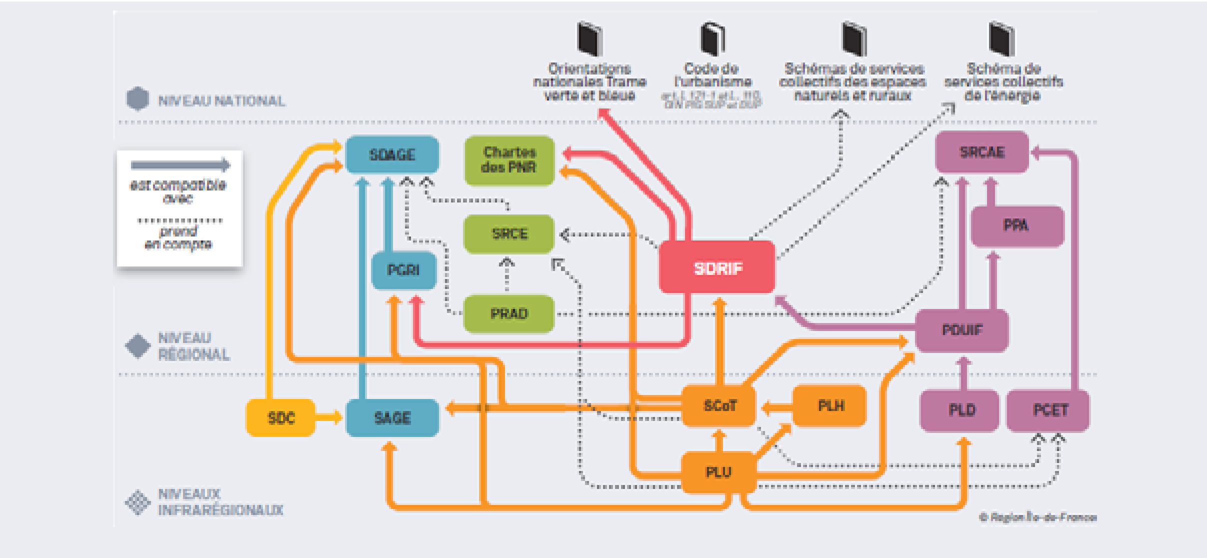


FIGURE 4: ↑ Biodiversity corridors and Agglomeration green grid. SOURCE : IAU îdF

FIGURE 5: ↓ A complex hierarchy of laws and documents regarding spatial planning

Open spaces are essential to the quality of life and for the fulfilment of various economic, environmental, and social functions. The regional master plan encourages open space preservation and the development of new open spaces. One way to preserve open space is by increasing the development density in various plans and reshaping the urban design. Other ways were to adjust extension capacities and to establish limits to urban sprawl in some sensitive areas with urban fronts of regional interest. The objective is to protect agriculture, forests and natural areas which are important carbon sinks. The regional master plan supports their functional viability and the preservation and creation of ecological corridors.

Densification involves designing the city differently, with a closer connection to nature. Therefore, the regional master plan determines the need for green spaces, in the heart of the agglomeration, by prompting municipalities to strive towards an objective of 10 m^2 of green area per inhabitant and to define an agglomeration green grid consisting of localise green spaces as well as recreational areas of regional interest. The Plan reserve 2,300 ha of new parks and gardens and an agglomeration green grid. The regional master plan also spurs the protection and the reopening of the rivers in the urban areas. These urban open areas and water spaces contribute to limiting soil sealing, thereby reducing flood risk from runoffs, and offer cooling zones to fight heat island effects.

Urban planning and environment are closely linked in the regional master plan. The regulatory value of the regional master plan ensures that consistent public policies are incorporated into the local town planning documents, the regional mobility plan and other sectorial documents. A shared monitoring-assessment system of the regional master plan ensures consistent follow-up of developments and their impacts on climate change. The public authorities are then able to act if these effects differ from the expectations. Using adaptation strategies will complement mitigation strategies, which aim to directly reduce the amounts of greenhouse gases and to protect and develop systems that act as carbon sinks.

FLOODING RISK MANAGEMENT NEEDS A MULTI SECTORAL APPROACH

The Regional master plan will have long term effect. But currently, management of climate change impacts face huge and present challenges as the vulnerability of the Paris region increases due to urban expansion and on-going climate change effects, which are mainly heat waves, flooding and storms. Urban expansion extends the area of vulnerability, increases built surfaces thereby contributing to higher urban temperatures, and increases impervious surfaces which increase runoff into streams and rivers. Several floods in the last few years demonstrate this increase[1].

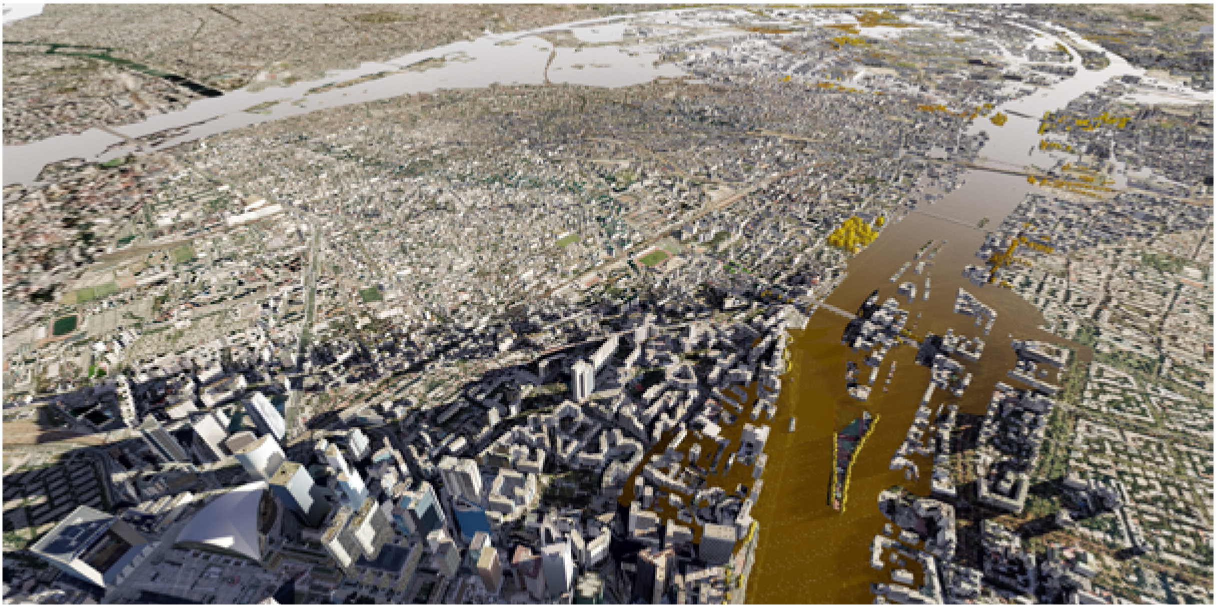


FIGURE 6: Flooding simulation and domino effect Paris's suburbs. SOURCE: Crue 3D

Flooding has emerged as a public safety and crisis management issue since the mid-2000s. The severe consequences of flooding on human settlements (435,000 homes and 830,000 exposed inhabitants are in flood plains) and socioeconomic assets (100,000 businesses and 750,000 jobs are located in flood plains) warrant the preparation of specific measures on risk management and prevention.

The effects of floods are numerous and cumulative. Tackling this issue requires a systematic approach considering the uncertainties and the domino effect on different urban networks, activities and urban services. These secondary impacts exceed the flooded areas and would influence the daily lives of millions of Parisians. The duration of the flood can reach several days to several weeks (cf. 2016 flood event) in the most affected areas, with consequences in terms of crisis management as well as the issues of the post-crisis. In fact, production and distribution of urban services (such as solid waste management, water treatment, sanitary and waste water treatment plant, large energy reservoirs, industrial factories and warehouses are organized around major structural facilities) are often located close to the rivers. The flooding of energy source posts and the medium voltage, together with emergency power disruptions, needed to protect the installations and facilitate their return to normal, has an impact on all the other networks and business sectors (water, telecommunications, transport, health, industry, etc.).

The metropolitan activities depend strongly on the mobility system. The main

FIGURE 7: Flooding event in Paris 2016.
SOURCE: S. Carrage/IAU îdF. Crue 2018 à Lagny (77)

public transport company RATP[2] revealed that in a hundred-year flood scenario, nearly 45% of its underground and mass transit train (RER) network would be stopped for several days to several weeks, with a significant impact on the several million daily trips. The national railway traffic would also be extremely disturbed at several major railway stations. Flood-related damage to the road networks would result in difficulties in obtaining supplies for the population, impact business logistics and even impact the organizations responsible for the management of the crisis and assistance. To secure main communication infrastructures is crucial for managing crisis.

In Ile-de-France, the normal operation of various regulatory instruments (civil security, safety of activities of vital importance, flood risk prevention plan...) are sectorial. During a crisis, when the domino effect spreads from one network to another, the continuity of operations relies largely on the management of the interdependencies between operators (energy, telecommunication, mobility, water, sewage). The extraordinary complexity of Paris region governance, with 8 districts, 1,276 municipalities, 64 "Territories", more than 700 intercommunal syndicates for public service delivery, and now a "Greater Paris metropolitan area" that covers only the core part of the agglomeration, makes coordination very difficult. The main challenge for resilience is then to find the way for managing these interdependencies, more than planning for crisis and post crisis management.

COOLING THE CITY

Recent climate records have shown a clear increase in the number, duration and intensity of heat waves in Ile-de-France region. By the end of the century, the region will probably experience an average of 11 days of excess heat per year. Urban heat islands are characterised by hotter air temperatures in central districts especially during the summer and at night. The shape of urban heat islands fluctuates according to the strength and reaction of dominant winds and warm breezes. During the night, air cools less quickly because of the heat released by materials in the form of infrared rays, which are trapped by the dense, compact surfaces of buildings. This heat releasing effect is primarily due to the presence of artificial surface materials, roughness length, scarcity of water and vegetation, and the presence of heat-emitting and polluting anthropological activity exacerbated by meteorological conditions.

Night time is a crucial period for organisms to recover from the effects of heat. However, during the 2003 heat wave the urban heat island reached a peak intensity of 8°C above the ambient temperature during the night, and double its usual intensity during the summer months. This had a direct negative effect on health and sanitary conditions. During this heat wave the Ile-de-France region had the highest overall increase in mortality in France.

The vulnerability of cities to the effects of summer heat waves affects the metropolitan ecosystem in terms of water resources, energy sourcing for air conditioning units, air quality, thermal comfort, alteration of natural elements, and the risk of degradation to buildings and infrastructures. The challenge of reducing vulnerability to heat waves is crucial when urban policies encourage increasing population density and the intensification of activities in current urban areas. Densely populated areas require specific solutions, such as the increased use of surfaces covered with vegetation, surfaces providing shade, the provision of water surfaces, the use of building materials with specially-adapted thermal and optical properties (albedo effect), the reduction of anthropogenic heat sources, and the morphology and configuration of various development zones, health services, district cooling, water management, etc.

Amongst the measures being considered, revegetation of the urban landscape constitutes one of the most efficient way to cool cities. Urban revegetation works in several ways: evapotranspiration; energy consumption due to the transformation of liquid water into vapour; and, the interception of a portion of the solar rays descending on the area by shading the ground and the surfaces of buildings. During the summer, these mechanisms contribute to the improvement of the urban microclimate. Revegetation of urban surfaces is a no-regret strategy.

Various options for revegetation exist: trees lining streets; grass or bush beds in roads and roundabouts; green belts around buildings; parks; undeveloped land; grassy ditches; agriculture and peri-urban forests, etc. Each option has distinct characteristics and therefore does not induce the same effects. Several scenarios have been tested at the Paris/Ile-de-France region scale (Muscade research project, Météo France model). In fact, all open-ground revegetation solutions are effective in terms of water runoff and the limitation of the effects of thermal stress felt by individuals at street level. The effect of revegetation strategies vary depending on the urban typology. Arboreal vegetation strategies are more effective especially in districts with multi-dwelling units. The cooling effect increases clearly with the rate of revegetation, to a maximum reduction of -2°C. Planted rooftops only appear to only produce benefits when they are irrigated, but with minimal results.

The cooling of the exterior microclimate, induced by revegetation, leads to a reduction in the use of air conditioning, and therefore of associated energy consumption. Without specific adaption, the consumption of energy used for air conditioning is very high. Non-irrigated planted rooftops can act as insulators, creating energy savings. Irrigation increases their evapotranspiration effect, leading to a three times reduction in final energy consumption. By regulating the exterior microclimate, revegetation strategies indirectly cause a reduction in the demand for air conditioning in buildings.

But the maximum reduction in energy consumption is brought by the synergetic effect of combining two revegetation strategies employing different physical mechanisms; cooling of the air at street level via arboreal revegetation in open ground in tandem with the insulating effects of roof gardens. Trees with higher mobilization of soil water and more ample foliage have a more effective means of managing ground water than herbaceous vegetation. Trees induce greater energy savings in terms of climate control with equal water consumption.

CONCLUSION - ESTABLISHING A GREEN AND BLUE GRID IS FUNDAMENTAL

The challenges of adaptation to climate change are intensified in cities. Generally, the answers adopted by cities are compactness and intensification to reduce mobility needs and greenhouse gas emissions. But densification increases the heat wave effect in the core part of the agglomeration and stress the ecosystem of the metropolis. Strong measures should then be adopted to reduce this vulnerability as it constitutes a major public health issue. In fact, climate change remediation modifies the hierarchy for actions in cities, setting greening (Green) and water resource management (Blue) as the top priorities.

FIGURE 8: Reintroducing Nature in the City.
SOURCE: C. Legenne/IAU îdF. ZAC Paris Rive Gauche, Jardins des Grands-Moulins - Abbé-Pierre; bassins à Paris (75)

Crisis management for flooding require more coordination between sectors because of the domino effect of affected urban services and activities, and its impact on the daily life of Parisians. This challenge requires a new governance model that is very difficult to implement in a metropolitan area like Paris/Ile-de-France region due to its extraordinary institutional complexity.

Crisis management for heat waves requires immediate measures mainly for fragile populations (the number of elderly in the Paris region is increasing). But cooling the city needs revegetation of urban areas while urban densification increases the price of the land and can reduce the green areas. The balance between densification and revegetation is a difficult challenge for urban policies that require support from different levels. Environment policies and legal framework should then be superimposed to urban planning.

The Regional master plan tackles the issue of climate change for the long term and tries to combine the intensification of the existing urban areas. It proposes mandatory regulation for densification on brownfields and around well-connected areas, and at the same time, defines the need to develop a green grid inside the core agglomeration with connections with the rural areas and ecological regional corridors. It also reduces the areas open for urbanization in flooding areas and encourage the opening of covered rivers.

In fact, climate change reposition some fundamental elements of urban planning to the top priority for planning cities. Green and blue grids are crucial elements to manage risks and cool cities and cannot be considered only as constraints for urbanization. Their implementation is the main condition to reshape cities facing climate change. The tools for reintroducing nature in the cities should be strengthened at all level of planning, from national/regional to local scales.

Climate change pressures stakeholders in metropolitan areas to find better governance between sectors and between territories to manage crisis and post-crisis. A resilient metropolitan management should be able to prevent, to alert, to manage crisis, and, to recover fast to normal level of activities and operation. It is mainly a question of coordination between sectors that are strongly linked in a metropolitan area.

Despite of large technical capacities for planning, analysing, and proposing solutions to the main climate change challenges facing the Paris/Ile-de-France Region, the major difficulties remain because of the institutional complexity of the metropolitan region. The low level of institutional integration at the regional level, which is the relevant scale for managing Paris/Ile-de-France metropolis, makes it difficult to implementation solutions to climate change impacts and to cool the city. Crisis events could be strong factors to trigger changes in the management of the system of actors, for the benefit of the population.

ENDNOTES

1 But they have never reach the highest level which occurred in 1910 when the Seine and the Marne rivers flooded Paris City

2 https://en.wikipedia.org/wiki/RATP_Group

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3D video simulation Flooding Paris. Source : IAU îdF

COLLABORATIVE STUDENT AND COMMUNITY DESIGN IN A TIME OF CLIMATE CHANGE
PLANNING A FLOOD-RESILIENT WATERFRONT IN NEW ZEALAND

XINXIN WANG, MATTHEW BRADBURY,
LUCIA CAMARGOS, MELCHIORS HUGH BYRD

FIGURE 1: Hīhīaua Peninsula (left) and Whangarei city centre (right).
SOURCE: https://upload.wikimedia.org/wikipedia/commons/c/ca/Whangarei_panorama.jpg

The environmental effects of climate change pose numerous issues to urban development located along coastal areas. New Zealand, an island nation surrounded by the Pacific Ocean, is facing great challenges caused by sea-level rise and more frequent extreme storm events. Therefore, planning resilient waterfronts that adapt to the changing climate is vital to the creation of sustainable urban development in New Zealand coastal cities.

Although research on rising sea levels has led to several national guidelines and policies, plans and actions have not been adequately developed at the local government and community levels. To deliver a climate adaptation plan that could motivate the local communities requires innovative design solutions and close engagement with community members to ensure their real needs are met.

This article presents a case study in Whangarei, New Zealand that demonstrates how student-community engagement can shape a sustainable urban waterfront adapted to the changing climate. The Hīhīaua Peninsula project was initiated by Momentum North (MN), a community group founded in 2016 based on Northland Region, in collaboration with the Hīhīaua Community and Unitec Institute of Technology. Hīhīaua Peninsula was chosen as the first project because of its central location, its waterfront features, as its consistency with plans from the Whangarei District Council.

FIGURE 2: Photos of the site.
SOURCE: Images credit to students Losa Nimo, Nick Slattery, Jingqian Sun and Benjamin Meredith

BACKGROUND OF THE COLLABORATION

The Hīhīaua Peninsula, located in the central area of Whangarei District, has strong connections to early European and Māori settlements. More recently, from the 1920s until the early 1970s, the peninsula was expanded by a series of reclamations. Nowadays, it is mainly used for industrial use with a small proportion of residential and recreational functions along the riversides.

Within the peninsula is a 16.5 ha triangular site formed by the confluence of the Hatea River and the Raumanga Stream. At the apex of the triangle is a park, which is to be the site of a cultural centre. There are several problems associated with using this site. Because it is in the low land of two waterways catchments and close to the sea, it experiences flooding caused by high-tide and storm events. Since most of the site is the product of reclamation, the site has land stability issues. Finally, because of the peninsula's industrial use, the site's soil contains contamination and other environmental issues.

In 2015 the Whangarei District Council, the ruling body of the regional capital of Northland Region, proposed growth plans for the city centre of the District. The Hīhīaua Precinct Plan proposed a waterfront masterplan with an intensification of residential apartments and commercial buildings. As part of this plan, the Hīhīaua Peninsula was identified as a site for future waterfront development. However, this plan did not meet the desires of Hīhīaua community, including local business, property owners and stakeholders, due to the increasing social needs and the environmental problems of that area.

In response, Momentum North and Hīhīaua Community wished to develop a more nuanced master plan where working and living together formed a rounded community with an emphasis on the importance of cultural values and a sustainable environment. Together they proposed five themes for future development:

- **WORK**: The community wants to have more opportunity for employment in the area.
- **PLAY**: The group wants the Hīhīaua to be a destination for recreation for the citizens of Whangarei.
- **LIVE**: Not many people live in the CBD, yet Whangarei is growing rapidly. Development in Hīhīaua is a great opportunity for people to live in the centre of Whangarei.
- **LEARN**: The peninsula could become a cultural and educational hub for Whangarei with the assistance of the He Puna Marama Charitable Trust, the Pacific Indigenous and Local Knowledge Centre of Distinction (Pacific Centre), the Northland Youth Theatre and the proposed Hīhīaua Cultural Centre.
- **VISIT**: Hīhīaua has great potential as a tourist attraction.

ORGANISATION OF THE STUDIO – MANDATE TO THE STUDENTS

In response to this mandate, Unitec Institute of Technology developed a studio during the first semester of 2017 as a joint course integrating architecture and landscape architecture courses. This project was seen as an opportunity to investigate underlying environmental conditions in the development of an urban waterfront. It also was an opportunity for students to gain experience meeting the expectations of the community members. Twenty two students in the fourth year of the Bachelor in Landscape Architecture and 22 students in the first year of the Masters of Architecture Professional participated in the studio. Students worked in 10 groups, with each group having both architects and landscape architects. They work collaboratively, both interdisciplinary and with the community. The lecturers asked the students to privilege the environmental and cultural factors to ensure an ecologically and socially sustainable waterfront masterplan.

The first phase was an investigation of the site, its surroundings and the key concepts that would drive the design in the next phases. This phase included research, data collection, GIS mapping, literature review, site visits and meetings with community leaders to identify their main aspirations. In the first three weeks, each group completed this initial research period by compiling relevant data, publishing that information online, and demonstrating the social, cultural, physical and biological arrangement of the site.

Each team was then directed to design a masterplan for the site that incorporated the aspirations of the community group (WORK / PLAY / LIVE / LEARN/ VISIT) into a well-reasoned concept plan. We asked the students to show synthesis GIS analysis, document appropriate case study investigation, and demonstrate innovative solutions to accommodate the forecasted population increase. This concept plan should also show the provision for a community space, including a place for a building and a public space. Over another three weeks, each group created a proposition exploring urban typologies, climate change, flooding risk, sustainable and resilient strategies.

In last phase of the project, students designed a new building and landscape for the Pacific Indigenous & Local Knowledge Centre of Distinction. The methodology of this course was based on research by design, and was conducted using different techniques:

- Studio discussion;
- Lectures and informal talks with experts;
- Meeting with the community;
- Presentation to the community;
- Informal pin-ups;
- Critique sessions.

FIGURES 3, 4, 5 AND 6: Site visit to Hihiaua Peninsula. SOURCE: Image credit to Xinxin Wang

STUDENTS AND THE COMMUNITY ENGAGEMENT PROCESS

A key approach employed in this design studio involved community engagement. Communication with the various stakeholders was initiated early on and continued through all design phases. The project lasted three and a half months, during which there were four major meetings, including site investigation, master plan presentation, building/open space design presentation and final presentation.

At the beginning of the project, students were guided by the MN members and community representatives. During this phase the site was thoroughly investigated.

Students were then welcomed by a Powhiri – a traditional Maori ceremony – held in a local school. The community and students then sat down for a discussion around their concerned issues.

FIGURES 7, 8 AND 9: Powhiri welcome (Traditional Maori ceremony). SOURCE: Image credit to Lucia Melchiors

MASTERPLAN PRESENTATION

The masterplan presentation was held in Whangarei. Using design drawings, videos and models, students presented 10 scenarios to the community. Over 20 community members participated in the presentation and had an intensive discussion around each solution. Students then amended their masterplan according to community's feedback and made detailed designs around a cultural centre and its open space. Tui Shortland was invited to come to Unitec for the building design critic. As Director of Te Kopu Pacific Indigenous & Local Knowledge Centre of Distinction, Tui played a critical role in the guidance, reinforcement and support for the design of the Maori and Pacifica Centre proposed for the site.

Informed by the community feedback and Tui's comments on cultural centre design, students produced their final outcomes. In the final presentation, five members of the community group travelled to Auckland.

The following *Table 1* summarises the process of student-community engagement process. It shows the design phases and how the process and activities were developed.


FIGURE 10 AND 11: Students presentation. SOURCE: Image credit to Xinxin Wang

STUDIO OUTCOMES

The studio produced a range of design ideas, from the radical idea dealing with massive tidal inundation, to more practical small-scale solutions. Key methods applied in the studio include GIS mapping, catchment analysis and sea-level rise data analysis. Based on extensive research and data analysis, students discovered a wide range of strategies to adapt to the changing climate. In the following section we present summaries of three of the student proposals for the project.

Table 1: Student-community engagement process

Design Phase	Engagement	Time	Location	Attendees	Activities
1-Research	Site investigation	March 9	Hihiaua	All students and lecturers MN, stakeholders and residents Local school students	MN guide students for site seeing Local school traditional welcome ceremony MN Introducing history, culture and expectation Discussion about problems and challenges
2- Design a masterplan	Masterplan presentation	April 4	Hihiaua	All students and lecturers MN and residents Mayor of Whangarei	Student present 10 design concepts Q+A section Community discussion and voting Community comments to each group
3 – Design a building or public space	Detailed design Crit	May 9	Unitec	All students and lecturers MN representatives Guest critics	Students present modified masterplan and how they transform masterplan concepts to detailed design Demonstrate solutions through design
	Final presentation	June 8	Unitec	All students and lecturers MN representatives Guest critics	Students conclude their research and design, especially sea-level rise adaptation, stormwater treatment and cultural aspect

SCENARIO 1

Scenario 1, produced by students Nick Slattery, Jingqian Sun, Losa Nimo, Benjamin Meredith, responds to climate change issues through the medium of landscape architecture. The GIS analysis of the site informed the design group that the surroundings of the site have serious risks of flooding in the future. Under the threat of a 3-metre sea-level rise in the next 300 years or so, the team envisioned that the Hīhīaua Peninsula becomes a learning island in the middle of the Whangarei lagoon. The human presence is limited on the island, while the natural and educational character is enhanced.

The Pacific Indigenous & Local Knowledge Centre explores the Samoan village as a key strategy to drive the design. The building has a strong connection to the landscape, to the cultural centre and the water. The landscape design explores a thoughtful use of Te Aranga principles [1] in the design of the planting.

The exploration of cultural aspects to drive the design was appreciated by some members of the community group. Tui Shortland commented: *"I love how the spatial arrangement of the Pacific Indigenous & Local Knowledge Centre is oriented to the Samoan Village."*

This scenario also showed the community group what can happen in the area as a result of future climate change. This element was uncomfortable, but it also was extremely relevant and provoked the discussion about the subject and showed the necessity to act to address the issue. As commented by one of the community members: *"I liked the concept of 'body, spirit, creativity and mind' and the layout and Pacifica atlas theme worked well for me. I will be castigated, but I did feel slightly uncomfortable with the high degree of sensitivity to climate change in this one. I am an optimist that thinks humankind can and will do better than we currently are and in time to make a difference of some magnitude. I also believe that there will be technologies developed to mitigate some of the worst effects of what will obviously be an unstoppable amount of global warming. Let's hope I am justified."* – Peter Ogle, Momentum North

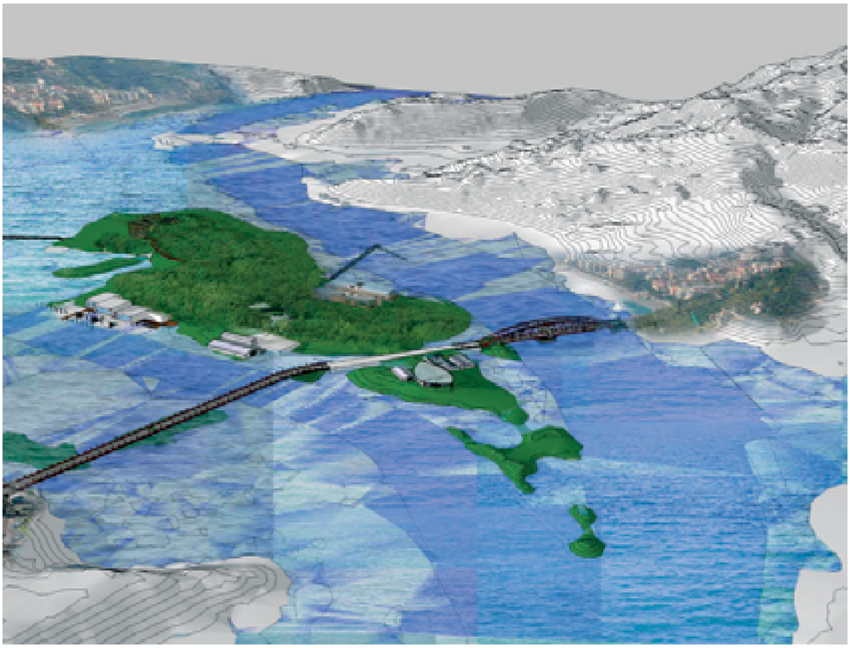

FIGURE 12 : Perspective of Hīhīaua in 2300 (Scenario 1).
SOURCE: designed by Nick Slattery, Jingqian Sun, Losa Nimo, Benjamin Meredith

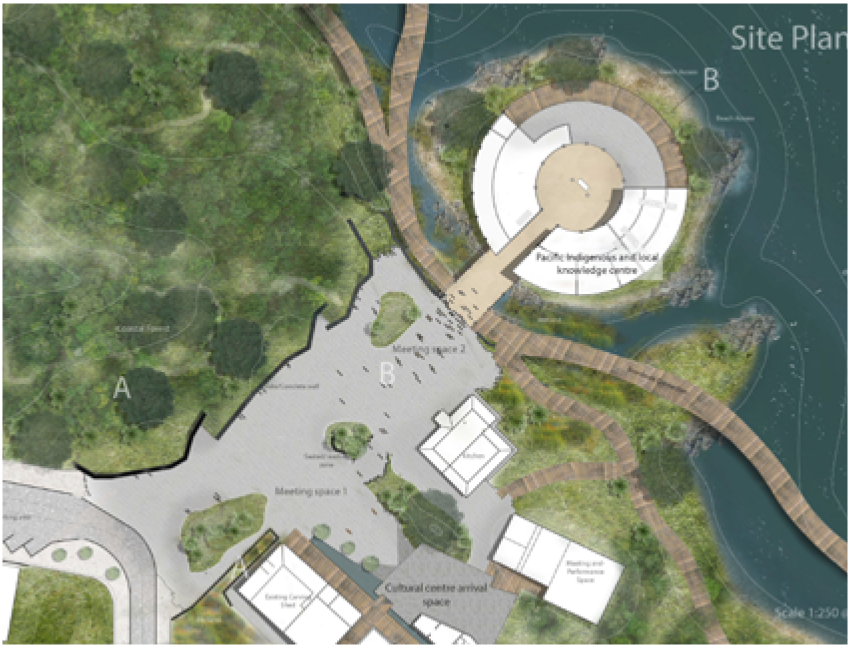

FIGURE 13: Site plan of Hīhīaua Cultural Centre (Scenario 1).
SOURCE: designed by Nick Slattery, Jingqian Sun, Losa Nimo, Benjamin Meredith

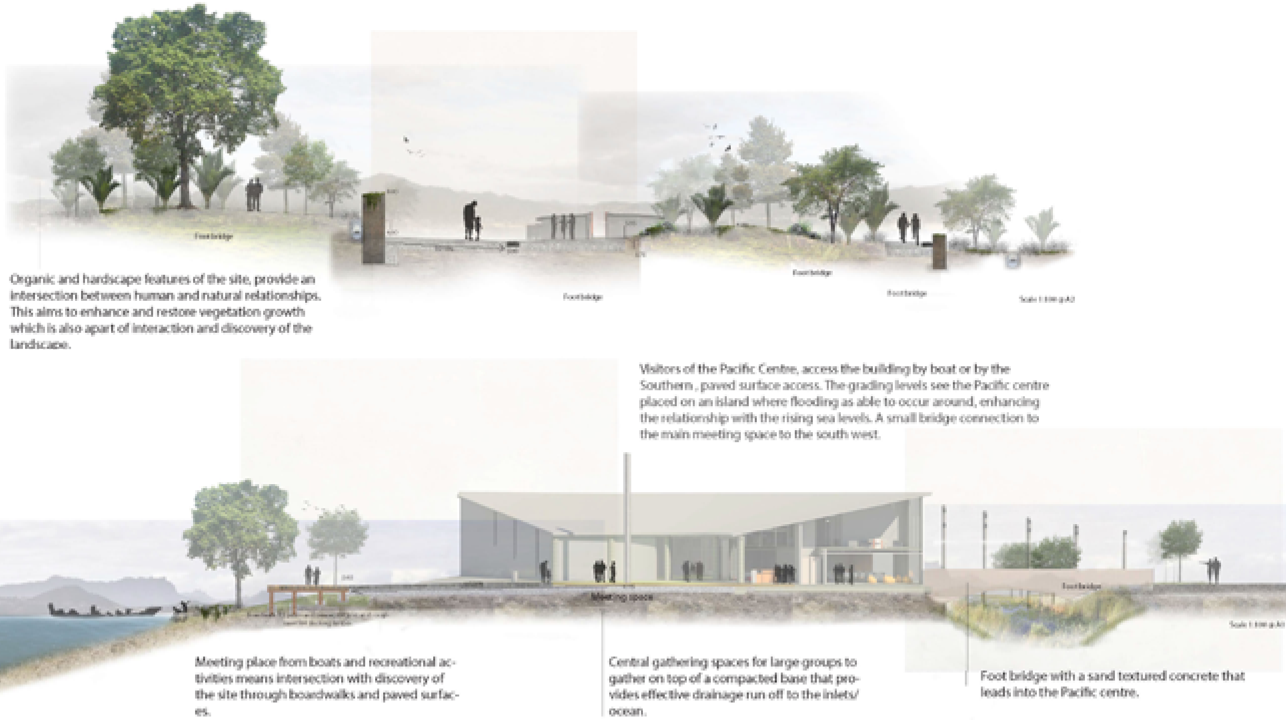

FIGURE 14: Cross-section of Hīhīaua Cultural Centre (Scenario 1).
SOURCE: designed by Nick Slattery, Jingqian Sun, Losa Nimo, Benjamin Meredith

SCENARIO 2

The Scenario 2 masterplan was prepared by Wesley Twiss, Yamen Jawish, Jill Koh, Sarah Mosley and Yujie Zou. It reflected the strong interest in water-sensitive landscapes. The flooding analysis and the wetland research informed important components of the masterplan, through an understanding of how the site responds to flooding. The northern edge of the site is designed as a soft and green area, enhancing connections with the river, and helping to purify the water. The southern edge has the major part of the construction. Between these two parts is the residential area, integrated with the landscape. The use of water inside the area attempts to restore the original river course, as it was before the land reclamations.

In the design phase, the concept is that of a village integrated the landscape and architecture. The Pacific Indigenous & Local Knowledge Centre surrounded by landscape, was designed as a group of buildings with a modest scale and quiet practically to be constructed in phases. The complex explores a sophisticated response to the brief, offering several different kinds of spaces for the users.

"The design of multiple buildings for the Pacific Indigenous & Local Knowledge Centre gives the impression that the centre is a complex itself. The round space for 'meeting in the streets in the Village' encourages integration" – Tui Shortland, Momentum North

FIGURE 15: ← Site plan for the village (Scenario 2).
SOURCE: Designed by Wesley Twiss, Yamen Jawish, Jill Koh, Sarah Mosley and Yujie Zou

FIGURE 16: ↓ Cross-section of the village (Scenario 2).
SOURCE: Designed by Wesley Twiss, Yamen Jawish, Jill Koh, Sarah Mosley and Yujie Zou

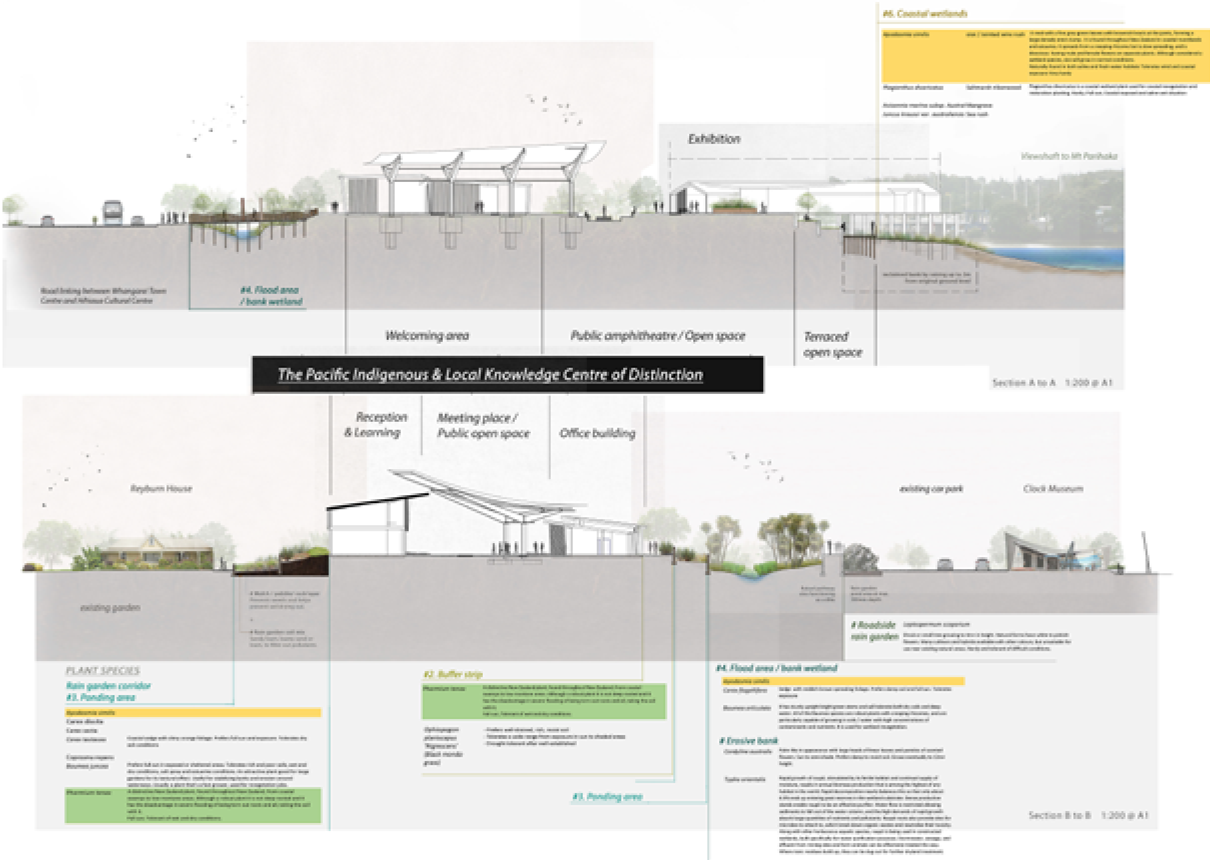

FIGURE 17: Perspective of the village (Scenario 2).
SOURCE: Designed by Wesley Twiss, Yamen Jawish, Jill Koh, Sarah Mosley and Yujie Zou

SCENARIO 3

Sharon Eccleshall, Sianne Smith, Vignesh Krishnamoorthy, Aleesha Kumar and Shibing Li produced Scenario 3 which explores some key principles in the masterplan phase: re-use of existing buildings, tactical urbanism and a clear strategy to embrace the flooding. The majority of existing buildings are preserved, with some adaptations such as green roofs and internal elevations to deal with flooding. The new buildings explore the shape of the existing industrial constructions. View shafts are created to enhance the connections with the surrounding mountains and rivers. An elevated path helps navigation of the site. The landscape uses the green stormwater infrastructure to help to reduce the effects of flooding by using green roofs, wetlands and vegetated retention ponds.

In the design phase, the plan develops a strong connection with the Pacific Indigenous & Local Knowledge Centre, folding the surroundings into the central public space, retaining, and emphasising the central 'street' at two levels. Three options were designed for this building, following the same core concepts. The public space is the result of an in-depth investigation of how a public space can be both a piece of green stormwater infrastructure and have civic qualities. The landscape proposes the use of indigenous vegetation to share Māori knowledge and Mauri Tu to clean contaminated stormwater.

The preservation of the buildings and the exploration of tactical urbanism were appreciated by the community as important aspects of this proposition: *"This project probably best met our original brief. It was clever in so many aspects. Firstly, it used a space that meant few would be disenfranchised by the new build. It had a central theme linked by the walkway but still managed to keep all options open. It meant that existing buildings or areas could be modified/replaced over time without compromising others, while still staying true to the spirit. 'Power to the people' involved community groups in the build."* – Peter Ogle, Momentum North.

FIGURE 18: Masterplan for Hīhīaua Peninsula (Scenario 3).
SOURCE: Designed by Sharon Eccleshall, Sianne Smith, Vignesh Krishnamoorthy, Aleesha Kumar and Shibing Li

INCREASE PERMEABLE | CREATE PLACE | REUSE EXISTING BUILDINGS |

THE LANDSCAPE DESIGN CREATES A CONTRAST TO THE EXISTING LIGHT INDUSTRIAL AREA. IT CREATES A JOURNEY BETWEEN THE HIHIAUA CULTURAL CENTRE (LANDING OF THE WAKA) AND THE PACIFIC INDIGENOUS AND LOCAL KNOWLEDGE CENTRE OF DISTINCTION (PLACE OF GATHERING)

THE LANDSCAPE HAS VARIOUS FUNCTIONS TO ACCOMODATE THE SURROUNDING BUSINESSES AND RESIDENTS. THE SITE IS SET UP TO ASSIST IN RESOURCE MANAGEMENT WITH WATER AS ONE OF THE MAIN DRIVERS.

THE INCREASE OF PERMEABLE SURFACE ALLOWS THE SITE TO CATCH/HOLD & FILTER RAINWATER AND THE WETLANDS CREATES RETENTION OF EXCESS WATER TO ALLEVIATE THE STORMWATER NETWORK.

SCALE 1:2500

FIGURE 19: Site plan for public open space (Scenario 3).
SOURCE: Designed by Sharon Eccleshall, Sianne Smith, Vignesh Krishnamoorthy, Aleesha Kumar and Shibing Li

FIGURE 20: Flood resilience strategy (Scenario 3).
SOURCE: Designed by Sharon Eccleshall, Sianne Smith, Vignesh Krishnamoorthy, Aleesha Kumar and Shibing Li

FINDINGS OF DEALING WITH CLIMATE CHANGE

Critical questions about the development of the contemporary waterfront in the age of climate change resulted in a series of strategies. This was particularly the case in dealing with sea-level rise where students produced strategies to embrace it, protect against it, or mitigate the flooding.

EMBRACING THE FLOODING

By adopting a resilient strategy that accepted flooding in some areas, the flooding problem could be accommodated. One of the techniques used by students was to raise the building footprint above the anticipated future sea level and to dig lakes/ rivers/streams to embrace water. Through close analysis of sea-level rise and a careful grading plan, the water-courses can not only ameliorate flooding, but also provide ecological benefits, recreational functions and add value to the site.

The Scenario 1 masterplan embraces the flood by accepting the anticipated sea level rise and creating a culture island to respond to this challenge. It proposed that all buildings be located in the middle of this new lagoon, creating a Noah's Ark solution to commemorate the existence of the city. Other groups designed gated water-ways to connect the hinterland with the coasts. The controlled water gates can balance the water level through letting tidal water in, or releasing stormwater runoff.

PROTECTING AGAINST THE FLOODING

To create mechanisms of flood protection, soft and hard solutions were used in some designs. These included solutions like elevating the terrain, creating barriers to the sea, and increasing the amount of pervious surface. Because the site is in the lowland of two wider catchments, flood protection is needed against both sea-level rise and stormwater runoff. Strategies used in these studies include concrete banks and tidal barriers along the coastal edge.

Using GIS analysis, water-sensitive design solutions to reduce flood risk were explored by most groups. By running a hydrological programme in GIS, overland flow paths were identified, and sub-catchments were generated. Through buffering the flow-path system to either side, a green space network was created. This strategies to protect the site from flooding created more space to filter stormwater and increased the ratio of pervious to impervious surface.

MITIGATING THE FLOODING

Different strategies and techniques were designed to mitigate the flood effects in the urban area: the use of vegetation, green infrastructure and stormwater management.

Native trees and shrubs were proposed to filter and mitigate stormwater pollution. Strategies used in students' designs included: green roofs, rain gardens, swales, wetlands and retention ponds. Through the combination of these devices, a stormwater treatment train was formed to mitigate flood-water.

CONCLUSION

The collaboration of community and students gave students opportunities to learn, discover, discuss, and identify critical issues that mattered to the community needs. The communication process also broadened the community's views of development and provided the community with many provoking options that exceeded their expectations. While the effect of climate change on the site wasn't at the forefront of the community concerns at the beginning of the project, the student's detailed investigation alerted the community to the impacts of sea-level rise and flooding risk.

Climate change is a long-term issue that need serious attention and continuous actions. This studio project produced ten flood-resilient solutions for the waterfront development in a New Zealand coastal city, each one deeply informed by the community perspective and needs. This project not only provided valuable experience for the students, it also received serious attention from the local authorities (Whangarei District Council) and has the potential to shape future council plan for the site.

The design outcomes were deeply associated with the community collaborative process and inspired diverse innovative solutions. The collaboration process raised awareness of the impacts of climate change and provided multiple benefits to students, community, and the local council. As a case study of a waterfront area in New Zealand, this project not only provided valuable insights into flood-resilience in the local context, but also contributed to a broader vision of cool planning in a time of climate change.

This project showcases the value of student-community collaborative design that has the potential to deliver real planning benefits in a time of climate change. As the Hīhīaua Peninsula masterplan is the first project selected by Momentum North, the success of this project will help the MN support other communities in Northland region and benefit local and national governments. As Peter Ogle summarised at the end of the project, *"The goal has been to stimulate Northland's economy by developing strategies and then to provide our local and national Governments with the backing and support of community members to turn those aspirations into reality. This has been the first small step and it has turned into a leap."*

Finally, the student efforts were well received. Ben Tomason, a leading member of the MN, comments *"After several site visits, meetings, workshops, blood, sweat, passion and reviews in Whangarei and Auckland, the Unitec Students have presented a truly masterful piece of work that far exceeded any of our expectations".* Another stakeholder said, *"You have done a wonderful service to* *our city and provided us with so many thought provoking options. When we first conceived the idea, I think most of that loose group of people known as Momentum North had a very different strategy for development of the area than we do now, after having had the benefit of your thinking. That is a wonderful success for all stakeholders."*

ENDNOTES

1 The Te Aranga Māori Design Principles are a set of outcome-based principles founded on intrinsic Māori cultural values and designed to provide practical guidance for enhancing outcomes for the design environment. (Auckland Design Manual, 2018)

THE CLIMATE RESILIENCE IMPLEMENTATION PLAN FOR THE eTHEKWINI SPATIAL DEVELOPMENT FRAMEWORK

KETLAODIRELANG EMMANUEL LETEBELE

FIGURE 1: An Image of Durban, South Africa's third largest city. SOURCE: Courtesy of Durban Tourism Board

BACKGROUND

The eThekwini Municipality is located on the east coast of South Africa in the province of KwaZulu Natal. Durban is a modern, multi-faceted, fast growing metropolitan city within eThekwini Municipality.

INTRODUCTION TO THE ETHEKWINI MUNICIPALITY SPATIAL DEVELOPMENT FRAMEWORK

It is said that by 2050, 6.5 billion people, or two thirds of the world's population, are expected to live in sprawling metropolises. To safeguard this future urban way of life, new forward-thinking strategies to mitigate and adapt to the impacts of climate change need to be integrated into conventional concepts of urban development. To that end, eThekwini Municipality has developed a Spatial Development Framework which outlines a development trajectory for short, medium, and long-term planning scenarios. The Spatial Development Framework presents a long-term vision of the desired spatial form of our Municipality, and thus, is critical for infrastructure planning which normally has a 5 to 20 year planning horizon.

The Spatial Development Framework guides the desirable spatial distribution of land uses within a Municipality to give effect to the spatial vision, goals, and

FIGURE 2: A map showing Durban, South Africa in the global context.
SOURCE: https://www.hakaimagazine.com/features/quick-sand-dirty-money/

objectives of the Municipality. It prioritises areas for spatial interventions and is aligned with provincial and municipal plans and strategies to ensure that the desired spatial form and outcomes of the Municipality are achieved both horizontally and vertically. When completed, the Spatial Development Framework is adopted by the Municipal Council[1].

Our Spatial Development Framework has been informed by key international, national, provincial, and local influences, as shown in the following diagram. Each of the strategies discussed later in this article should not be seen in isolation, but as integrated components of an overall framework for sustainable development of the city.

The plans for the development of our municipality and its built environment are underpinned by global, national, and regional policy. The objectives of these policies have influenced our strategic and spatial direction. The most recent and relevant international developmental policies that informed our Spatial Development Framework are listed and described below.

FIGURE 3: Key Spatial Development Framework informants.
SOURCE: eThekwini Municipality Spatial Development Framework (2017-2018)

- The **New Urban Agenda** officially adopted in Quito, Ecuador in November 2016. This agenda provides a 20-year "roadmap" to guide global sustainable urban development. The 2030 agenda is built around a series of Sustainable Development Goals. Most relevant to the New Urban Agenda is Sustainable Development Goal 11, which aims to "make cities and human settlements inclusive, safe, resilient and sustainable".
- The **Sustainable Development Goals** intention is to be a universally shared common and globally accepted vision to progress to a just, safe, and sustainable space for all inhabitants.
- **Sendai Framework for Disaster Risk Reduction 2015-2030**: The Sendai Framework is a 15-year voluntary, non-binding agreement which recognizes that the State has the primary role to reduce disaster risk, but also finds that this responsibility should be shared with other stakeholders including local government, the private sector, and other stakeholders. It aims for the following outcome: "The substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries".
- **The Addis Ababa Agreement** – The Addis Ababa Action Agenda provides a foundation for implementing the New Urban Agenda. The agreement was reached by the 193 United Nations Member States attending the United Nations Third International Conference on Financing for Development.
- **Paris Agreement** – The Paris Agreement is universally regarded as a seminal point in the development of the international climate change regime under the

FIGURE 4: An image of the Sustainable Development Goals.
SOURCE: eThekwini Municipality Spatial Development Framework (2017-2018)

United Nations Framework Convention on Climate Change (UNFCCC). The Paris Agreement was adopted on 12 December 2015 at the 21st session of the Conference of the Parties to the United Nations Framework Convention on Climate Change Conference of the Parties 21. The Agreement was the result of four years of intense negotiations mandated by the United Nations Framework Convention on Climate Change Conference of the Parties, held in Durban in 2011.

The Agreement is a comprehensive framework which guides international efforts to limit greenhouse gas emissions and to meet all the associated challenges posed by climate change. The main objective of the Agreement is to limit the global temperature increase to well below 2 degrees Celsius, while pursuing efforts to limit the increase to 1.5 degrees. South Africa is a signatory to the Paris Agreement and has an obligation to limit temperature increases to 1.5°C, above pre-industrial levels.

We have customised the ideas in the above global documents to suit the prevailing conditions in Durban. For example, the Spatial Development Framework

FIGURE 5: An image of Durban. CREDIT: K.E.Letebele, 2018

contains strategic responses to climate change, including the Durban Climate Change Strategy, which is part of the Municipal Climate Protection Programme. This programme defines a city-wide approach of adapting to climate change and mitigating Durban's contribution to climate change. It covers 10 themes: water; sea level rise; biodiversity; food security; transport; energy; waste and pollution; health; and economic development as well as recognizing knowledge generation and understanding as cross-cutting fields.

The vision of the Durban Climate Change Strategy is: "To transform Durban's governance, social, development and economic systems in order to effectively respond to climate change".

It guides the implementation of climate related work done within the Municipality, its governance framework, and the subsequent development of implementation plans[2] supported through the C40 2020 Climate Action Planning Programme. It enables better co-ordination between municipal sectors and structures helping to build a climate smart city.

HOW WE HAVE BENEFITTED FROM INTERNATIONAL ADVICE

Our plans have also been influenced by the participation of Municipal officials in international partnerships and learning exchanges. These events have informed our spatial planning response to climate change and mitigation. The following section describes some of the partnerships we have entered to mainstream our climate change response work.

FIGURE 6: A global map illustrating the location of Cities Fit for Climate Change Partner Cities.
SOURCE: Cities Fit for Climate Change (CFCC) International Dialogue Forum on Climate-Proof Urban Development Workshop II (2017). Santiago de Chile

GLOBAL PROJECT CITIES FIT FOR CLIMATE CHANGE PROJECT

The global project 'Cities Fit for Climate Change' implemented by GIZ[3] on behalf of the German Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) establishes a program for the exchange of ideas, about mitigating climate change and increase resilience to climate-related shocks, between various Germany cities and three international partners cities. Santiago (Chile), Chennai (India), and Durban (South Africa) were selected by agreement with the relevant national ministries and authorities. The decisive selection factors were the commitment of the mayors and city councils, and the city's level of climate change vulnerability. Each city determines their project priorities, which might be, for example, the climate-proofing of instruments, strategies, regulations, the implementation of participatory city development strategies, or the development of financing options for realising available climate protection and adaptation concepts. Each partner cities exchanges knowledge with each other and with other cities within the framework of the exchange workshops. In South Africa the programme is being co-steered by the South African Local Government Association, which is responsible for developing and coordinating the implementation of the Integrated Urban Development Framework. The eThekwini Municipality was selected in cooperation with the Ministry.

Cities Fit for Climate Change aims to strengthen cities as actors of sustainable development, and to assist cities in the development of integrated, resilient, and

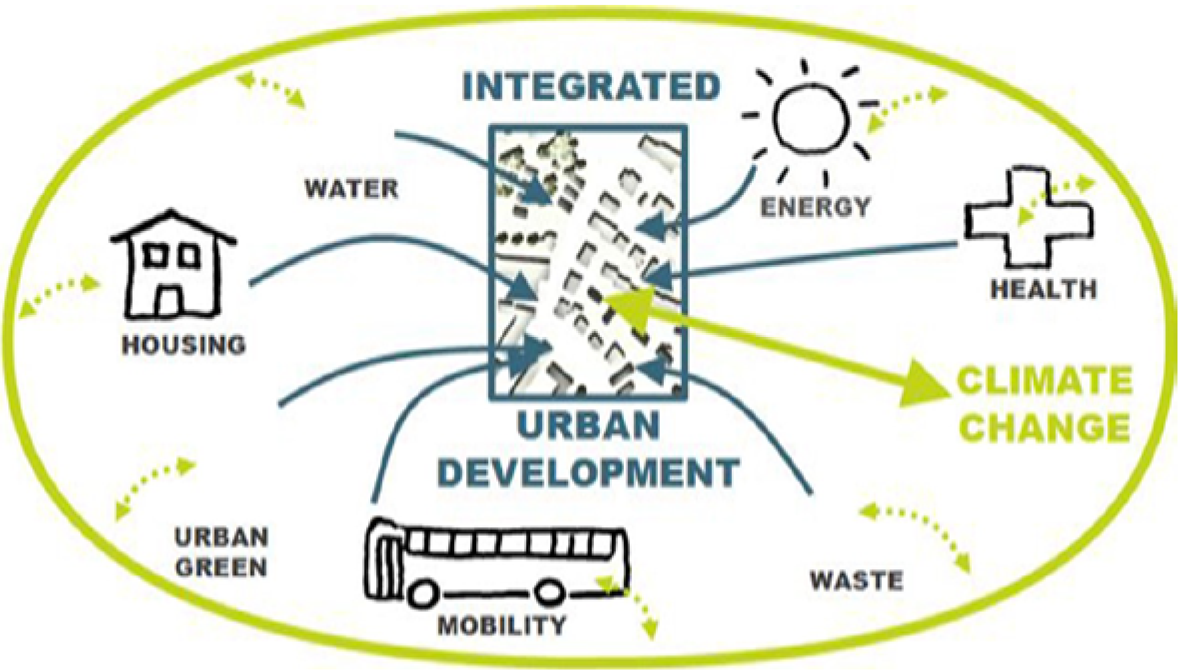

FIGURE 7: A figure illustrating an integrated view on urban development and climate change.
SOURCE: Cities Fit for Climate Change (CFCC) International Dialogue Forum on Climate-Proof Urban Development Workshop II (2017). Santiago de Chile

low carbon instruments for sustainable urban development. The development of these instruments will facilitate a Climate Proof Urban Development Model, which promotes a new urban design vision. With this model, the project supports innovative approaches for urban planning and makes cities “fit for climate change”.

A fundamental question is how can cities, as drivers and victims of climate change, cope with the risks and become custodians of a liveable climate? This project is focused on finding answers to this question. Because there are no universally applicable solutions, existing concepts for resilient low carbon urban development are being analysed and compiled in a sourcebook. Selected cities are being supported to develop case-specific, climate-friendly, locally adapted strategies which are derived from this knowledge base. This work was guided by the ‘Leipzig Charter on Sustainable European Cities’ and the BMUB Memorandum ‘Urban Energies-Urban Challenges’.

It is the intent of the program to share the collected knowledge at international conferences, such as the International Society of City and Regional Planers (ISOCARP) Congress, and to support the United Nations Framework Convention on Climate Change process. The Program also contributes to the implementation of the ‘New Urban Agenda’, the international agreement of the Habitat III process.

INTERNATIONAL LEARNING EXCHANGE WORKSHOP OF THE CITIES FIT FOR CLIMATE CHANGE PROJECT IN PARTNERSHIP WITH CONNECTIVE CITIES. DURBAN, SOUTH AFRICA, FEBRUARY 2017.

Three 'inter-connected' workshops were planned; one in each of the participating partner cities. At each workshop new elements of climate-sensitive urban planning can be incrementally developed into a new urban development model that draw on real city-level case studies. The first was held in Durban in February 2017. It hosted urban practitioners from the partner cities together with representatives from the German cities of Hagen, Nuremberg and Stuttgart, the Swedish City of Malmö, the South African Local Government Association (SALGA) and members from GIZ SA (Climate Support Program).

These exchange sessions were intended to enable and facilitate peer-to-peer knowledge sharing, support and collaboration, the joint generation of new knowledge, and the promotion of innovation with regards to the planning of low-carbon and resilient urban development. The meetings were to discuss analysis tools, city development strategies, planning approaches, implementation frameworks etc. revised to reflect climate change considerations with the resultant outcome- to make cities low-carbon and resilient to the impacts of climate change.

The workshop objectives were:

- To establish the status quo regarding the integration of climate change issues in urban development instruments and strategies of the partner cities;
- To learn from existing practices and innovations in climate sensitive urban development;
- To identify synergies between the existing urban development instruments and strategies;
- To develop a roadmap for the workshop series with the intermediate steps needed for conceptualizing a new climate-sensitive urban development model.

To generate workable solutions for the next workshop, the primary aim of the Durban workshop was to discuss lessons from successful efforts that can replicated on the various projects and programmes presented by the participating cities. A key outcome of the Durban workshop was the realization that for climate change adaptation and mitigation strategies to gain traction in cities, they need to be main-streamed into urban planning development and not viewed as a separate discipline or add-on.

After the Durban workshop, the eThekwini Municipality developed a meaningful implementation plan for the Durban Climate Change Strategy, which mainstreams climate adaptation and climate resilience into the planning processes,

FIGURE 8: An image of the Moses Mabhida Stadium in Durban which lends itself to the usage of Non Motorist Transportation. SOURCE: K.E.Letebele, 2018

such as the Spatial Development Framework and lower order spatial plans.

In general, our implementation plan aims to assist in the development of integrated, resilient, and low carbon instruments for sustainable urban development. The development of these instruments will promote a new urban design vision, which supports innovative approaches for urban planning and makes cities "fit for climate change". Furthermore, our approach ensures that the implementation of the Climate Resilience Implementation Plan is undertaken through agreed municipal procedures and integrated into relevant municipal planning and decision-making processes.

The integration of the Climate Resilience Implementation Plan outcomes will feed into the Non-Motorized Transportation and active mobility strategy for eThekwini amongst others. Efforts are underway to lobby support from all municipal departments to prioritize and incorporate climate change responses into their mid-term budget review in line with their respective mandates. This stems from the fact that the Spatial Development Framework is a multi-sectoral plan, and therefore when each sector implements an action linked to climate change then the outcome of the Climate Resilience Implementation Plan will be seen through to implementation as part of that process.

FIGURE 9: Santiago de Chile. SOURCE: https://www.gettyimages.com/photos/santiago---chile

We also recognized that we need to think globally, but act local, to take meaningful steps towards climate change mitigation and adaptation. Furthermore, we learned that cities should not work in isolation of each other, their nation-states, or the global community. We recognized that solutions for climate changes need to address a multiplicity of issues for a city and cannot merely be about climate change protection and or mitigation alone.

INTERNATIONAL DIALOGUE FORUM ON CLIMATE-PROOF URBAN DEVELOPMENT, SANTIAGO DE CHILE, SEPTEMBER 2017

The International Dialogue on Climate Proof Urban Development was held to map trajectories for a climate-friendly future. This dialogue forum involved the participants from seven different cities, including the three partner cities and four German cities (Leipzig, Nuremburg, Frankfurt and Munich). The German cities were invited to share information regarding their work on climate-proof urban development and to learn from the Cities Fit for Climate Change partner cities.

The main objectives of the Santiago Cities Fit for Climate Change dialogue forum were to:

- Generate networking opportunities between Cities Fit for Climate Change partner cities; and,
- Learn about and exchange information regarding municipal practices and climate-proof urban development experiences from the participating cities.

The Santiago International Dialogue on Climate Proof Urban Development concentrated on how to change institutional patterns to achieve enhanced integrated urban development. A cross cutting theme of the workshop was "The Governance of Local Climate Action and How to Foster Multi-Stakeholder Collaboration". It was at this International Dialogue session that emphasis was placed on the definition of Climate-Proof Urban Development as follows:

> *´In connection with spatial planning and spatial development, climate proofing includes methods, instruments and procedures that ensure that plans, programmes and strategies, as well as the associated investments towards the current and future impacts of climate change will be more resilient and adaptable, and that they also aim for the corresponding plans, programmes and strategies to take into account the aim of climate change mitigation' (Birkmann and Fleischhauer, 2009).*

The above definition points out that to achieve a climate proof urban development a collective action from all stakeholders responsible for urban development is required.

Two site visits in the city of Santiago were undertaken to showcase urban development projects and the climate considerations that come with them. The real-life examples, Bajos de Mena, in the municipality of Puente Alto, and Ciudad Parque Bicentenario, in the municipality of Cerrillos, were discussed to illustrate the challenges and opportunities of climate-proofing urban development in district neighbourhoods or infrastructure projects. Both projects were selected to represent examples of national policy implementation in urban development, as well as to stimulate conversation regarding the challenge of integrating climate change related elements into such projects.

BAJOS DE MENA

Bajos de Mena is a historically neglected area, 20 kms away from Santiago with more than 120,000 inhabitants. It was built to provide social housing, but without territorial planning. Bajos de Mena is a social housing condominium area located in the southern periphery of the city of Santiago. It is a neighbourhood of high complexities with the following characteristics: "precarious condition of habitability with serious problems of violence and insecurity; lack of infrastructure and public- private services; and, above all, deteriorated relationships with authority and feeling of abandonment by the State".

One of the primary challenges is to incorporate climate change adaptation into the new plan by generating pilot development projects which include renewable

FIGURE 10: An image illustrating the built form in Bajos De Mena. SOURCE: K.E.Letebele, 2017

energy and water efficiency among other actions. The plan is to evaluate the impacts of these interventions and to determine the feasibility of scaling up such approaches. The plan is led by the Regional Government of the Metropolitan Region of Santiago, in direct coordination with various public and private services.

The Second Chance Plan for this area was incorporated into the Bajos de Mena Integral Plan, under the direction of the Integral Plans Unit of the Metropolitan Intendencia. It proposed housing and neighbourhood improvements, more transport infrastructure, services, green areas, and new security prevention plans. It also seeks to provide the area with services (banks, supermarkets, police, public, services, etc.), improved housing quality (isolation, bigger spaces), connectivity, and public areas focused on sustainability in terms of living standards, both in social and environmental terms.

The project highlights the co-benefits and synergies between the various social and climate related challenges, by incorporating adaptation initiatives that respond to both social and climate problems identified by the local community, such as flooding in certain areas of the various neighbourhoods. However, there is still work to be done in terms of transportation and connectivity, as well as energy efficiency and supply.

The experience generated by the project points towards a recommendation to clearly understand the pertinent climate change risks prior to any urban intervention, by performing a vulnerability and risk assessment. This allows for climate

FIGURE 11: An image of the public open space in the Bajos de Mena Park.
SOURCE: http://www.planintegralbajosdemena.cl/las-5-lineas-del-plan-integral-para-bajos-de-mena/

change related challenges to be integrated from the beginning of the project, instead of having to integrate such considerations after the development phase has begun.

CIUDAD PARQUE BICENTENARIO

Ciudad Parque Bicentenario (CPB), also known as the Bicentennial Park of Cerrillos, is an urban-real estate project located in the commune of Cerrillos within the metropolitan area of the city of Santiago , Chile. The project was designed to commemorate the Bicentennial of the Country in 2010.

CPB is an integral urban project led by the Ministry of Housing and Urban Development (MINVU). The project program consists of the reconversion of 250 hectares of the former Los Cerrillos Airport into: a 50 ha park; a proposed development of about 16,500 homes to be developed over the next 20 years; the development of Sports Village for the Pan-American Games to be held in Santiago on February 2023; the development of homes to be transferred to the Chilean Air Force; and, apartments for the institution's members. Due to its size and location, the CPB provides an opportunity for implementation of public policies that promote the improvement of the quality of life of its inhabitants and the environment.

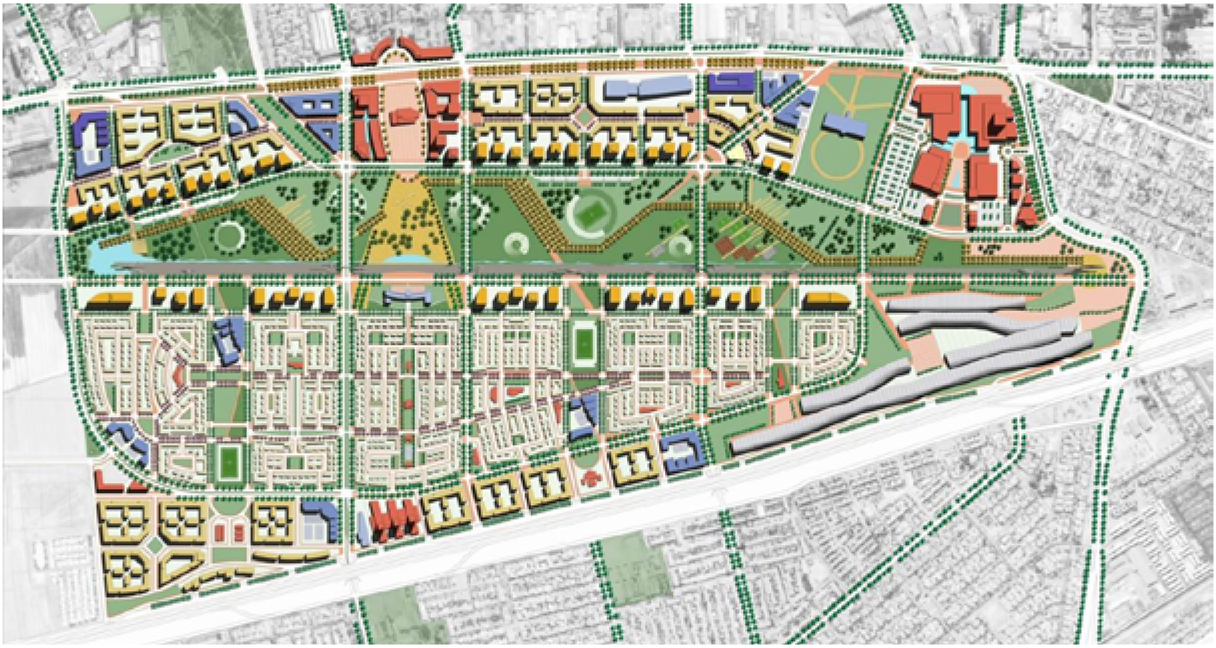

FIGURE 12: ↑ Plan City Bicentenario Plan.
SOURCE: http://www.urbe.cl/urbe/wp-content/uploads/2013/05/Plan-Maestro-Portal-Bicentenario-1.jpg

FIGURE 13: ↓ An image depicting the public open space within Ciudad Parque Bicentenario SOURCE: K.E.Letebele, 2017

This project attempts to consolidate a new form of city, which enhances the role of the state in guiding urban development with an emphasis on building socially integrated, environmentally sustainable neighbourhoods, fully equipped with quality public spaces and a very good standard of green open spaces. Emphasis was given to initiatives such as water collection in the lagoon, the integration of urban gardens and organic waste management into the courtyards, climate modelling of the structures and their orientation, and connections with surrounding neighbourhoods.

As a demonstration project for Santiago, this project seeks to set a benchmark for Chile and the Latin American countries in terms of three primary pillars: sustainability and a response to climate change; urban design; and, social integration. It is perceived as an urban laboratory where new urban policies are and will be tested. A mixed-use approach will be employed to assimilate changes that are happening in Santiago into this project. It will be developed by both public and private entities. It is interesting to note that the incorporation of climate change considerations into the project was an outcome of the practitioners from Santiago participating in the Cities Fit for Climate Change.

A key finding that emerged from Santiago was that Climate change is not an environmental issue, it is about politics, planning and it is a transversal phenomenon. It was also emphasised that it is important to convince political leadership to address Climate Change issues beyond their political term of office to ensure that new leaders assume their predecessor's role and continue advocating for Climate sensitive spatial planning.

INTERNATIONAL DIALOGUE FORUM – CHENNAI, INDIA

The Dialogue Forum in India, Chennai will be held in August 2018. The focus of the Dialogue will be the Rehabilitation of the Buckingham Canal in Chennai**.** This process has been generating various social conflicts, related to high levels of pollution as well as periodic floods. The restoration is planned for 3 km of the canal in the southeast sector of the city, and consists of cleaning the river, fencing it off, constructing tracks for running and protecting dikes and other activities. Following the implementation of this project, the restored area could be used as a model for the rest of the canal.

The existing urban development guidelines and concepts of our partner cities are to be adapted according to climate-proofing principles. Climate-proofing means that city development strategies, urban designs, land use and master plans, and all related investments are resilient and adaptable to the current and future impacts of climate change. Furthermore, corresponding climate protection measures need to be taken, and they must be aimed at decarbonisation.

These steps will provide the basis for designing an individualised climate-proof urban development model for each city. The development of urban green space is an example of how carbon emissions can be reduced while at the same time adapting to climate change impacts. These green spaces help prevent heat island effects, reduce flooding, absorb carbon from the atmosphere, and improve air quality – all leading to an improved quality of life. Climate proofing is a win-win situation for the inhabitants, city budgets, and the climate.

CONCLUDING REMARKS

The following important lessons were derived from our participation in the Cities Fit for Climate Change program: how to conceptualise and frame climate change responses; how national and city-level policies can support cities in dealing with the impacts of climate change; how valuable the contributions of civil society can be, working in partnership with government; the value of hard science and building scenarios; and, what institutional arrangement within cities and across government are helpful in promoting climate change resilience at the local level.

A strong coherent and coordinated future vision that is owned, not only by city officials and politicians, but by the residents, will assist in embedding climate change adaptation and mitigation measures into local level planning and hold leaders accountable. A common vision can pull together communities, departments within a city and the various government agencies that operate at the local level and galvanise these actors into action.

The climate-proof urban development approach represents an important framework for how to pursue climate change adaptation and mitigation in the context of urban planning. Based on the experiences of the participating German cities, many interesting ideas, urban development processes and lessons learned were identified as being of great use for the cities involved in the Cities fit For Climate Change projects, as well as for other cities experiencing similar difficulties regarding climate-proofing urban development.

ENDNOTES

1 As required by the Municipal Systems Act, Act No. 32 of 2000 and the Spatial Planning and Land Use Management Act No. 16 of 2013

2 Supported through the C40 2020 Climate Action Planning Programme

3 Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. 2017. The global project 'Cities Fit for Climate Change' implemented by GIZ on behalf of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB).

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URBAN FORESTS AND CLIMATE CHANGE METRO VANCOUVER'S APPROACH

AMELIA NEEDOBA, JOSEPHINE CLARK,
CAMILLE LEFRANÇOIS

↑↑ TOC

FIGURE 1: This image is fairly typical of the Metro region's second growth native conifer forests today. Prior to urbanization, the region was blanketed in lush temperate rainforest populated with old growth trees that were some of the largest on earth. SOURCE: Ben Parker Photography/Shutterstock.

Metro Vancouver is the region forming the southwest corner of Canada that includes 21 municipalities, one Electoral Area and one Treaty First Nation working together to plan for and deliver regional scale services. The landscape ranges from steep mountains to sea level agricultural lands and is bisected by the Fraser River, a major source of fresh water for agriculture, fisheries and natural landscapes. In a satellite image the region appears green with tree canopy, though comparing successive historical images reveals an increasing built environment comprised of urban centres and roadways.

Located within the urbanizing area, the urban forests contribute to the health and well-being of our communities. This green infrastructure provides many services including stormwater regulation, air quality, energy savings and carbon sequestration. A recent report from the TD Bank estimated that the urban forest provides annual benefits in the region of $224 million (CAD) (TD Economics 2014). In addition, studies show links between urban forests and human health. For example, a study of the emerald ash borer outbreak in the eastern United States found it was associated with more than 20,000 additional human deaths due to lower respira-

FIGURE 2: This image is fairly typical of the Metro region's second growth native conifer forests today. Prior to urbanization, the region was blanketed in lush temperate rainforest populated with old growth trees that were some of the largest on earth. SOURCE: Amelia Needoba

tory system and cardiovascular-related illness (Donovan et al. 2013).

Within the Metro region concern for the protection of green spaces, including urban forests, is intensified by the recognized impact climate change is having on our urban forests. For example, trees are stressed by longer periods of summer drought and soil damaged by heavier winter rain storms; both of which increases risks of fire, insect, and disease outbreaks. Given the many and complex ways the urban forest benefits our communities, it is imperative that urban forests be planned and managed as critical urban infrastructure.

To this end, Metro Vancouver recently completed the Urban Forest Climate Adaptation Project, a study of the risks and predicted changes to our urban tree canopy, including recommendations on how our member jurisdictions can prepare for and adapt to the predicted changes. This article provides a summary level description of that project and its recommendations.

FIGURE 3: ↑ Even as the exploitation of the forest resources was the major attraction of settlers, the west coast forest fascinated people with its magnificent trees, which attracted tourists to Stanley Park as early as in the 1800s.
SOURCE: City of Vancouver Archives

FIGURE 4: ↓ Logging was a key industry as settlers began to establish in the region, with the large trees of the old growth forest being shipped around the world.
SOURCE: City of Vancouver Archives

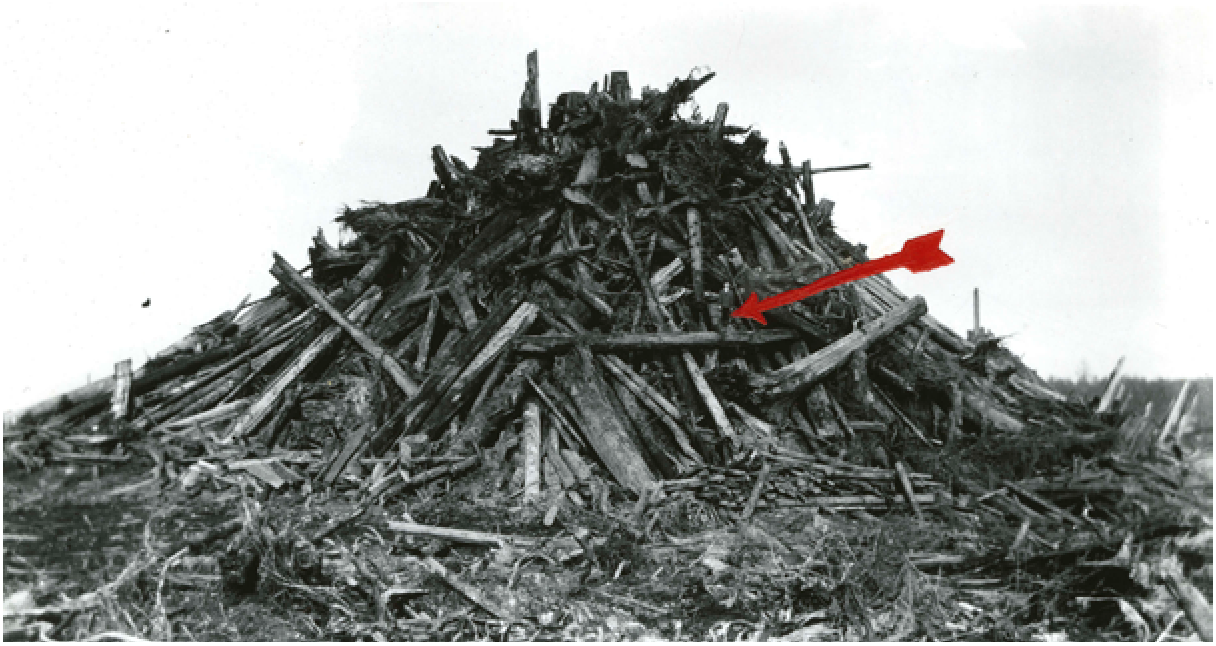


FIGURE 5: The clearing of our region's urban centres yielded so much material that impressive piles of wood were left lying in areas surrounding colonial settlements. Forest clearing debris contributed to a destructive fire that burned through Vancouver in 1886, destroying most of the buildings and killing many.
SOURCE: City of Vancouver Archives

LOCAL CONTEXT FOR THIS RESEARCH

In the Pacific Northwest of North America, the Pacific Ocean to the west and mountain ranges to the east create a climate with heavy rainfall in the winter, spring and fall, and comparatively dry mild summers that support temperate rainforest vegetation and productive ecosystems. The native forests are dominated by coniferous tree species- Douglas-fir, western red cedar and hemlock – and these forests are still evident in the extensive protected areas in the north of the region. Remnant forests can still be found in the more urban areas, most famously in Stanley Park which sits adjacent to the City of Vancouver's downtown core.

The focus of this research is the urban forest, which includes trees located in parks, around buildings, lining the streets and in backyards. These trees are predominantly managed and regulated by each member jurisdiction. Much of the urban forest now reflects European and Asian landscape influences. Streets are typically planted with continuous rows of the same species, often imported species of smaller flowering trees. Parks are often landscaped with turf and large ornamental trees in addition to any retained native species. The most common

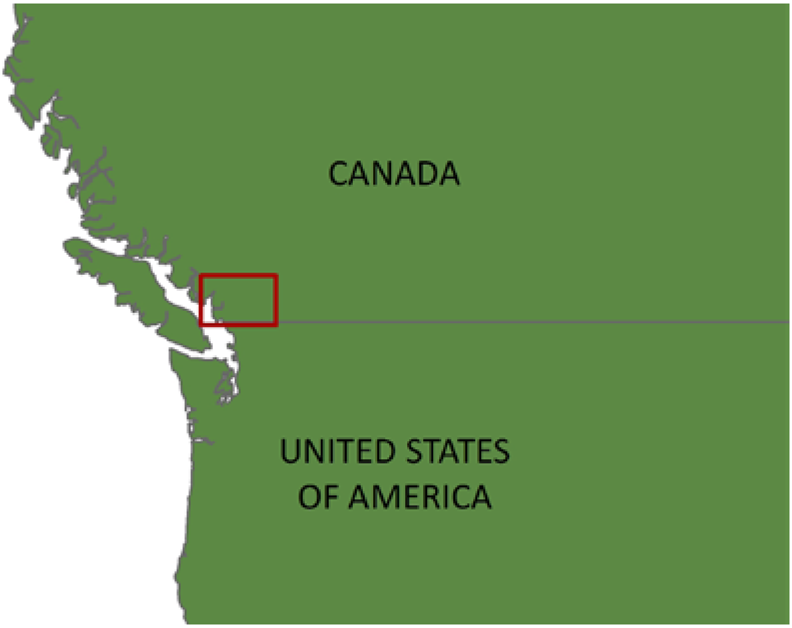


FIGURE 6: The Metro Vancouver region is located on the Pacific Northwest of North America, just north of the USA-Canada border.
SOURCE: Metro Vancouver

FIGURE 7: Land cover mapping shows that Metro Vancouver retains high levels of forest cover overall, alongside multiple urban centers.
SOURCE: Metro Vancouver

non-native trees in our regional urban forest are maples, cherries, elms, ash, lindens and oaks.

Metro 2040 (Metro Vancouver's Regional Growth Strategy) provides a shared vision of a 'liveable, sustainable region for current and future generations, and a recognition that this is only possible if we ensure a healthy natural environment' (Metro Vancouver, 2011). But there are challenges to achieving this vision. The region has 2.5 million residents, and anticipated growth sees 35,000 new residents and related homes and jobs arriving every year. Accommodating this growth while avoiding sprawl requires increased development in existing urban areas. Competition for land is high, and the region is experiencing declines in greenspace and canopy cover.

Climate change presents cities with another complex set of challenges. In order to reduce future uncertainty and support adaptation planning, Metro Vancouver commissioned the Pacific Climate Impacts Consortium (PCICs) to look at the details of how the regional climate may change by the 2050s and beyond (Metro Vancouver, 2016). By downscaling projections from global climate models, they were able to predict how changes in temperature and precipitation will play out locally. The climate future for Metro Vancouver will be warmer (more like present day San Diego), with less snowpack and increased rainfall. Summers will become drier and other seasons wetter (particularly fall), with more frequent and intense extreme storm events. 'Climate projections for Metro Vancouver' presents some key indicators from the projections.

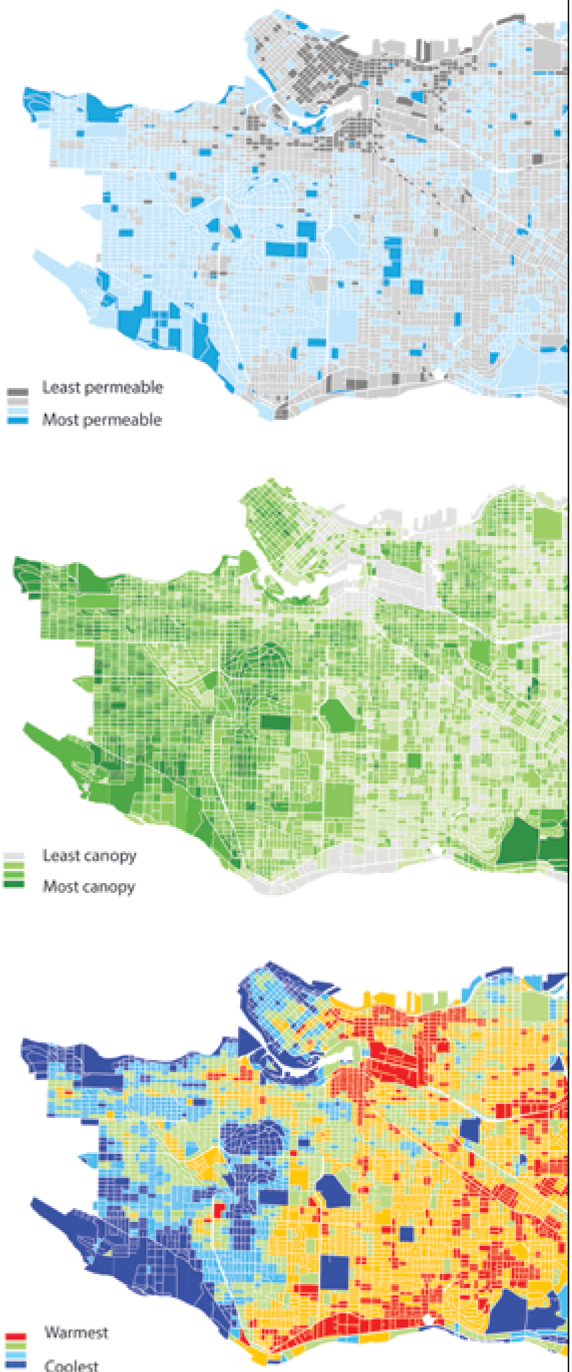
Climate projections for Metro Vancouver - Key Indicators

	Past 30 year average	2050's Average Change	2080's Average Change
Summer daytime high temperatures	21°C	+ 3.7°C	+ 6.0°C
Total precipitation in fall	580 mm	+ 11%	+ 20%
Total precipitation in summer	206 mm	- 19%	- 29%
April 1st average snow pack depth	292 cm	- 58%	- 82%

WHAT DOES THIS MEAN FOR URBAN FORESTS?

Urban forests offer a natural defense against climate change by cooling streets and buildings, improving air quality, intercepting rainwater, storing carbon, and providing habitat and forage for animals and pollinators. However, the urban forest is vulnerable to climate change. Research on Pacific Northwest forests shows that climate change has caused mortality rates to double in old forests (Van Mantgem et al. 2009), while annual growth and regeneration rates have declined (Beedlow et al. 2013, Erikson et al. 2015). Yellow cedar - an important and abundant species in British Columbia's temperate rainforest - is experiencing one of the most severe declines of any forest species in the world (Daniels et al. 2012). At the same time, the climate is favouring insect and pathogen activity (Carrol et al. 2004), and wildfire (Westerling et al. 2006).

While considerable academic, government research and modelling work is focused on the impacts of climate change on natural forest ecosystems and forestry industries, we have less information about the expected impacts on trees in planted urban forests. In addition, the scientific literature that is relevant to this region is not readily accessible to urban foresters. To bridge this gap, Metro Vancouver used the PCIC climate projections, regionally relevant scientific literature, and a working group of academics and professionals to identify the likely impacts on urban trees in this region. Out of the range of potential climate change impacts this group concluded that Metro Vancouver's urban forest will be most vulnerable to reduced soil moisture availability and increased wildfire, heat, fresh-water flooding, insect, disease and invasive plant activity. In particular, reduced soil moisture due to warmer, drier summers will be a widespread and likely annual concern across the region, exacerbating drought and heat stress in urban trees, reducing annual growth and increasing mortality rates among vulnerable trees.



REAL WORLD HEAT EXAMPLE

In 2009, Metro Vancouver experienced a heat wave, with temperatures exceeding 30 degrees Celsius for three days. While not hot by global standards, this was about 10 degrees warmer than the average maximum of the previous 10 years, and much hotter than our population is accustomed to.

Within days of this extreme heat event, deaths among Metro Vancouver residents increased by around 40% with 110 excess deaths attributed to this heat event (Kosatsky et al, 2012). Most of those deaths occurred at home, rather than in institutions. Most people who died were in neighborhoods with social vulnerabilities, and these areas are also typically those with least canopy cover, which exacerbates the heat.

As can be seen comparing Figure 10 (surface temperature map) with Figure 9 (canopy map), the urban areas that experience the highest temperatures are often those with the lowest canopy cover. The shade provided by larger trees cools city streets and low-rise buildings, offering an effective way of providing relief to urban residents during heat waves.

FIGURES 8,9,10: A study from Ho et al. (2017) derived a map of land surface temperature on a hot summer day based on Landsat data. These maps from the City of Vancouver's Urban Forest Strategy show the spatial relationships between surface temperature and tree canopy and permeable surfaces. They show a relationship between the presence of tree canopy and permeable surfaces (such as grass, gardens or bare ground) and cooler surface temperatures.

SOURCE: FIGURE 8 AND 9: City of Vancouver Urban Forest Strategy 2018; Figure 10: Data from Ho et al. (2017)- City of Vancouver Urban Forest Strategy 2018

TOOLS TO ADAPT URBAN FORESTS

Metro Vancouver's Urban Forest Climate Adaptation project provides urban forest practitioners with guidance on how to increase resilience within our tree population and in our urban landscapes. The project suggests three management approaches which we will examine in turn:

1. Reduce vulnerability in the existing tree population by improving growing conditions and adopting best practices for tree care.
2. Select tree species that will be well adapted to future climate, the intended planting site and have characteristics that will meet site design criteria.
3. Design sites to support healthy trees and maximize the climate adaptation benefits they provide.

REDUCE VULNERABILITY TODAY

Purpose: Reduce vulnerability in our existing tree population by improving growing conditions and adopting best practices for tree care.

In a natural environment, a healthy long-lived tree species can live for hundreds or even thousands of years if conditions are favorable. In urban environments like streets, tree life expectancy is usually much lower, averaging 19 to 38 years in many North American cities (Roman and Scatena, 2011). Regardless of a species potential life-span, urban tree life expectancy is lower because we create conditions that make trees vulnerable to disease and decay, or conflicts that require their removal.

Urban trees are vulnerable in modern urban developments. When early streets and residential areas were built by hand, soils were left largely intact and not heavily compacted. Road surfaces were permeable, and drainage was often open, allowing water to infiltrate into the surrounding soil. Establishing street trees was easy, and many of the large trees in urban landscapes today started out in those conditions. In the oldest parts of Metro Vancouver, it is not uncommon to find original soils and tree roots underneath roads and sidewalks.

Cars, trucks and heavy machinery, from the mid-twentieth century onward, dramatically changed our streetscapes and urban development practices. Technology and machinery advanced to enable earth to be manipulated more efficiently making it harder and more durable to build on. Today, landscapes are usually graded to manipulate surface water flow and improve the efficiency of building. Topsoil is often permanently removed. Drainage is piped to enclose ditches and moves surface water away quickly. Paved surfaces are impermeable, and subsurfaces need to be compacted to exclude water and bear the load of heavy vehicles or structures.

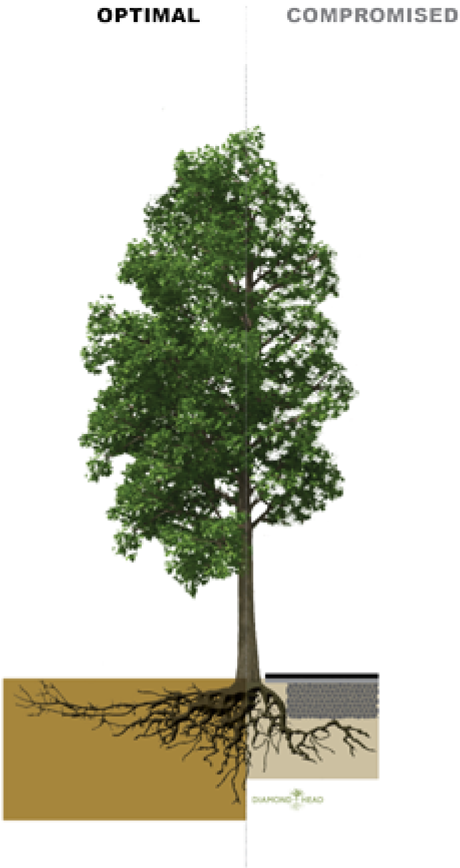


FIGURE 11: The 'Framework' assesses how vulnerable Metro Vancouver's urban forest is to the impacts of climate change and provides guidance on how to increase resilience and prepare for the future. The accompanying tree species database can be searched and filtered based on physical attribute information, future climate suitability, and urban site suitability to help practitioners select the best species for their site. Source: Metro Vancouver (2017). 'Urban Forest Climate Adaptation Framework for Metro Vancouver. Tree Species Selection, Planting and Management'

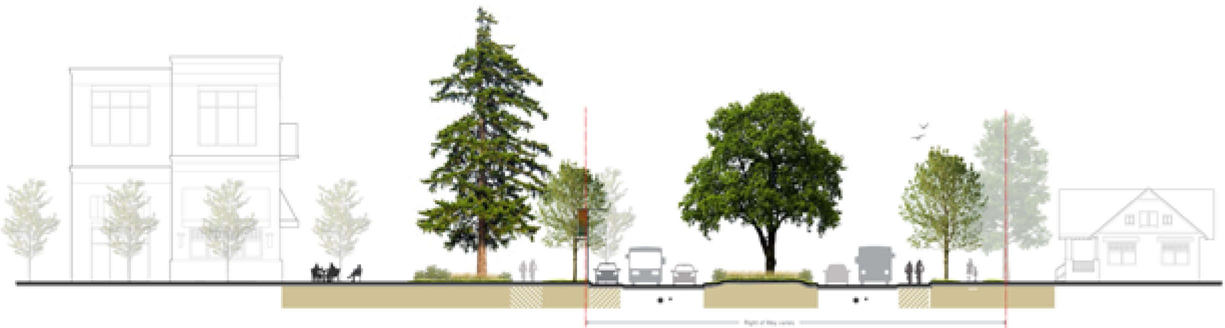


FIGURE 12: The 'Design Guidebook' provides site-specific guidance on how to ensure healthy trees and maximize climate adaptation benefits. Source: Metro Vancouver (2017b). 'Design Guidebook. Maximizing Climate Adaptation Benefits with Trees'

FIGURE 13 (SOURCE: Camille Lefrançois) & FIGURE 14 (SOURCE: Amelia Needoba): Street trees are often planted into degraded growing sites with compacted soil and low permeability. Where roots grow can be a sign of these conditions. For instance, compacted soils can restrict roots to the surface, or to find opportunities to grow under sidewalks and in utility trenches where roots can cause conflicts.

While these practices are efficient for construction and the durability of hardscape, a trade-off is the compromised quality and quantity of soil available for trees in densified urban areas. The large, old trees are replaced by young trees, often planted in degraded growing sites with compacted soil and low permeability. The trees that succeed in heavily-urbanized areas today are usually those that can escape the confines of their intended planting sites and find adequate soil volume and moisture elsewhere, ideally in adjacent yards or parks but often in less compacted utility trenches under sidewalks where roots cause conflicts.

In addition to challenging growing conditions, today's urban trees also need to resist the climate change impacts of intensified summer drought, and increased insect, pathogen and fire activity. Metro Vancouver's "Urban Forest Climate Adaptation Framework" (Metro Vancouver, 2017a) provides guidance for reducing stress in the urban forest through soil management, planting infrastructure, water management and tree management practices.


FIGURE 15 AND FIGURE 16: Vancouver's earliest roads were built by hand and street trees were planted into soils with relatively intact structure and less compaction. Trees planted into these early streets were able to grow their roots in soil under roads and sidewalks. Even today it is not uncommon to find the roots of mature trees under old sidewalks or roads when they are being reconstructed. SOURCE: City of Vancouver Archives

Promoting the growth of healthy and resilient urban trees for this region requires:

1 Soil and planting infrastructure design and construction practices to:
· Maximize soil volume;
· Prevent soil compaction;
· Increase soil water storage capacity and reduce water loss;
· Minimize competition at planting sites;
· Minimize soil texture interfaces; and,
· Preserve or improve soil quality.

2 Water management practices to:
· Irrigate efficiently;
· Encourage passive water harvesting strategies;
· Encourage active water harvesting strategies;
· Reduce vegetation water demand;
· Maximize proportion of permeable surfaces; and,
· Explore emerging opportunities such as grey water use for irrigation.

3 Tree management practices to:

- Care for newly planted trees;
- Implement scheduled pruning programs;
- Install tree protection barriers during construction;
- Protect suitable trees and supervise works around trees during construction; and,
- Maintain wind firmness.

REDUCING THE VULNERABILITY OF URBAN TREES

There are many ways in which municipalities in Metro Vancouver and around the world are already improving urban trees' growing conditions.

FIGURE 17: Soil cells can be used to provide additional soil volume for trees on sites that need to support heavy weights such as vehicles. This site in the City of North Vancouver is using silva cells to provide more soil for tree roots to grow into. Stormwater from the street is being redirected into the soil via an adjacent catch basin. Excess water is captured by a drain line at the bottom of the cells connected to a downstream catch basin.
SOURCE: Deeproot

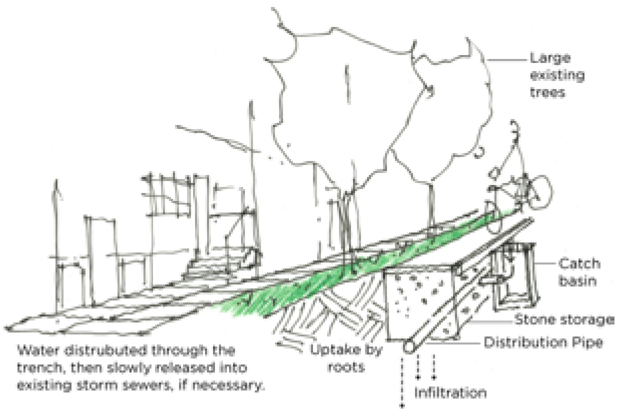


FIGURE 18: The City of Vancouver is building a new bike lane, and used this as an opportunity to include permeable pavement which will allow more rainwater to make its way to the roots of the mature trees already lining the street. Curbside catch basins will also collect rainwater from the street to the soil through a perforated pipe.
SOURCE: City of Vancouver

ADAPT TO THE FUTURE

Purpose: Select tree species that will be well adapted to future climate, the intended planting site and have characteristics that will meet site design criteria.

Climate suitability of urban trees is broadly controlled by species tolerances for temperature and precipitation. The study defines three main questions to determine future climate suitability:

1. COLD TOLERANCE Are the future local climate conditions too cold for that species? Determined using projected future extreme minimum temperatures (Metro Vancouver, 2016) and the US Department of Agriculture (USDA) plant hardiness zones.
2. HEAT TOLERANCE Are the future local climate conditions too hot for that species? Determined using projected future extreme maximum temperatures (Metro Vancouver, 2016) and the American Horticultural Society (AHS) heat zones
3. DROUGHT TOLERANCE Will the site provide sufficient moisture in the future for that species? Determined using projected climatic moisture deficits (Wang, 2012) and assessed drought tolerance of numerous northern hemisphere tree species (Niinemets and Vallardes, 2006).

Using this decision framework, the study reviewed 144 species that grow locally. For all species reviewed, drought tolerance was the determining factor for future climate suitability in this region – where cold is predicted to be less limiting and heat is not predicted to become limiting.

To provide greater context for each of the 144 species assessed, we developed a species selection database that includes relevant tree attributes and site suitability recommendations in addition to future climate suitability. The database is a standalone tool to assist practitioners in selecting the right tree for the right place. Users can obtain a species list based on the type of urban site (e.g., streets, highways, playgrounds etc.), or from other categories such as size, soil volume, tolerances or risks. It also includes practitioner comments to share experience with different species and cultivars from across the region.

DESIGN SITES TO MAXIMIZE CLIMATE ADAPTATION BENEFITS WITH TREES

Purpose: Design sites to support healthy trees and maximize the climate adaptation benefits they provide.

Healthy trees that are well adapted to future climate are expected to function well and deliver services such as shade, stormwater management, water quality improvement, and carbon sequestration. But if our intention is to maximize the benefits trees provide to the community, then we need to design our plantings to deliver those services explicitly where they are needed. As a companion to the Urban Forest Climate Adaptation Framework, Metro Vancouver's "Design Guidebook: Maximizing Climate Adaptation Benefits with Trees" (Metro Vancouver, 2017b) provides illustrations and additional technical guidance to support the design of tree plantings to maximize benefits to local communities throughout Metro Vancouver.

This guidebook serves as a reference and resource for land managers and municipalities to support landscape design projects, design guidelines updates and for designing new developments. It can also be used by the development community as a resource guide for best practices in incorporating climate adaptation within development programming and design. Specific guidance is provided for roads, parking lots, building edges, playgrounds and other typical urban places. For each typical place, the guidebook covers:

- Adaptation benefit opportunities (e.g., shade, stormwater, carbon sequestration)
- Description of typical place context (e.g., road widths, potential constraints and opportunities)
- Tree placement options (e.g., curbside, median)
- Species selection considerations (i.e., attributes to sort on in the species database)
- Planting site design preferences (e.g., open tree-pit, passive water harvesting)
- Recommended targets for spacing, canopy cover and permeability

CONCLUSION

REACHING OUR GOALS

The Urban Forest Climate Adaptation project provides a first step towards building resilience in this region's urban forest. A resilient urban forest for Metro Vancouver will be one that is integrated into planning, design and construction. Trees need to be recognized as service-providing infrastructure and given the space and conditions to provide these services effectively. Changing current practices to better support urban trees is a significant challenge. It requires funding and support at political and management levels, and a knowledgeable, multidisciplinary staff to implement new practices.

Many local governments have developed urban forest strategies, introduced tree protection bylaws, developed design guidelines and public tree management standards. These steps represent progress and an increasing recognition of how important trees are to our urban areas. However, we have a long way to go before trees and green infrastructure are as well integrated as grey infrastructure into the policy, practices and budgets that govern private and capital development projects.

SIGNS OF POSITIVE CHANGE

Technology and research offer a range of approaches to improve permeability, water infiltration and soil volume in engineered environments. These solutions become increasingly feasible as they are more widely implemented and prices drop. In this region, research on the urban forest has increased with the recent launch of an urban forestry program at the University of British Columbia, attracting local and international academics and students. Over time, we hope that this new academic program and other local institutions will conduct research to reduce the uncertainty and knowledge gaps in our understanding of climate change impacts on the urban forest and the most effective responses.

Metro Vancouver's Urban Forest Climate Adaptation project does not future-proof our urban forest against climate change, but it does serve to document our current assumptions, concerns and strategies for adaptation. This documentation will help to inform current and future decision-makers who shoulder the burden for implementing climate adaptation strategies for our region's communities.

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URBAN FORM AND CLIMATE CHANGE

LUÍSA BATISTA

FIGURE 1: Lighthouse engulfed in waves in Porto, Portugal. SOURCE: Lusa

INTRODUCTION

After decades of evolution, the climate change narrative has reached a relevant stage of dissemination across different knowledge fields (from biophysics and technologic areas to human and social sciences), and it now frequently uses multidisciplinary approaches. It is evident that most scientist endorse the concept of climate change. Even everyday society has given more attention to its common-sense narrative by noticing the undeniable evidence that the climate has changed and can strongly affect people lives. People are becoming aware that extreme climate events are more frequent. It is harder to clearly distinguish the seasons as we used to do. Even the popular media contributes to the public awareness of this issue by reporting more articles devoted to climate change and related issues, such as economic and territorial impacts of the climate change process, economic impacts of extreme climatic events, human costs measured in lost lives, public health impacts, and demographic impacts, such as the increasing refugee's flows from areas negatively affected by climate change.

In addition, there is decisive scientific evidence of the anthropogenic origins of the massive GHG emissions linked to climate change. This steady progression of emissions, begun in the industrial revolution and continued to the globalized present world, gives us the awareness that if we don't act the future will be worst and climate change impacts will be costlier.

FIGURE 2: Summer 2017, Portugal - the largest fire of the year, in the world. Resulted in extensive area of burning forest (more than 500 thousand hectares), settlements invaded by fire, deaths (more than a hundred), economic activities destroyed. SOURCE: Lusa

Presently, there is a major consensus about the need to focus climate change responses on cities, to act on the main sources of GHG emissions (mainly through transportation and buildings), and to improve the resilience of those areas where most of the world's population live. As a result, there has been great activity and effort by local policy agencies to conform with the international framework of environmental conventions and agreements, such as the 2016 Paris Agreement, where new goals for global warming were defined, resetting others established in the past. Recent times are prolific with the production of guidelines and practice guides intended to help the design and implementation of climate change responses by using urban planning. Such local initiatives are intended to reduce GHG emissions and promote the resilience of communities and territories by adapting them to new climatic scenarios, thereby diminishing the magnitude of negative impacts of extreme climate events.

To assist in this effort, we need to recognize that urban form plays a relevant role in climate change response. Urban form has the potential to benefit urban climate mitigation strategies and climate adaptation strategies, as reported in various literature and institutional research reports. Urban form also has the potential to reduce GHG emissions, thereby contributing to a slowdown of global warming, and the potential to improve communities' resilience by minimizing the exposure to climate risks using interventions targeting crucial elements such as urban tissue, streets, squares, buildings and plots (Condon et al., 2009; Dubois et al., 2012; Hamin and Gurran, 2009; Stone et al., 2010)

FIGURE 3: Summer 2013, Lisboa, Portugal - increasingly intense and frequent heat waves. SOURCE: Público

WHY CITIES SHOULD BE AT THE CENTER OF CLIMATE CHANGE RESPONSE?

A large part of the world's population lives in cities. Not surprisingly, cites are also responsible for 67% of primary energy use and 71% of GHG emissions, mainly resulting from transportation and built environment functions. So, we need to look at cities as the core of an efficient climate change response. Additionally, we should not forget that the concentration of people, infrastructure and material goods in cities, makes cities more likely to sustain extensive damage and loss of life from climate related disasters, such as heavy rains and droughts, sea level rise, floods, hurricanes and storms, hot and cold peaks, and changes a region's ambient temperature and rainfall. The disruption of economic systems, the displacement of coastal communities and port facilities, the shortages of food and water supplies, the public health and safety impacts, and population migration flows are examples of the great challenges posed by climate change to contemporary cities.

FIGURE 4: ↑ Summer 2016, Funchal, Portugal – city invaded by fire. SOURCE: Lusa
FIGURE 5: ↓ Winter 2010, Funchal, Portugal – flash floods. SOURCE: Jornal de Notícias

Climate change forces urban planners to improve mitigation strategies focused on cities to achieve the goal of restricting the rise in the global temperature to less than 2°C (related to pre-industrial era) and make an effort to limit it to 1.5°C). The evidence of forecasted climatic scenarios and global warming also forces the urban planner to develop adaptation strategies to improve the resilience of cities (EEA, 2016; IPCC, 2014). Due to the importance of cities, if urban responses to climate change is unsuccessful, the whole global strategy will be unsuccessful too.

Thus, the challenge ahead is to focus on what cities must to do to reduce energy and resource consumption and to become more resilient and less vulnerable.

WHY URBAN FORM MATTERS IN CLIMATE CHANGE RESPONSE?

Natural conditions, such as topography, soil and subsoil quality, sun and wind exposure (climate in general) and the type of natural landscape highly influence urban form. Climate change would affect many of these natural conditions. Urban Morphology, the discipline that studies urban form, has echoed this climate change debate, placing the focus on the physical form of cities and its potentialities in the development of urban strategies for mitigation and adaptation to climate change (Oliveira, 2016).

Although the connection between urban form and climate is not new, we need to rethink city form considering the relation between the unique characteristics of each city, its new climatic realities, and its future risks. This ambitious and challenging task could not be carried out without considering the role of the new technologies, especially those related with energy, and without considering contemporary urban lifestyles. Regarding urban form in the context of climate change there are three key mitigation issues: compactness, spatial arrangement and urban design.

Studies confirmed that compact cities consume less energy; that higher densities reduce the dependence of the automobile; and, that mixing land-uses provides greater proximity and an improved identity of neighborhoods and, therefore, potentially less displacement.

New spatial arrangements of urban form can have significant impacts on travel made by residents, workers and visitors in a given city (Condon et al., 2009). Planning climate change response through interventions in the urban form can reduce the number and distance of vehicle trips, if reliable transit to and from employment is provided, and if services are located within easy walking distance of home. For example, a reduction in travelled distance of 20 to 40 percent can be achieved in compact urban developments, compared to automobile dependent suburbs. Reduced travel results in reductions in fossil fuel consumption and GHG emissions (Ewing et al., 2008).

FIGURE 6 & 7: Porto, Portugal – density vs sprawl. SOURCE: Google maps

Intervention to the design of the urban form (buildings, streets, plots, squares) can create a new equilibrium promoting city resilience. A street improvement that enables a public transport policy can also be an opportunity to enhance solar orientation and refacing adjacent building with materials which enhance energy efficiency in heating and cooling. For example, streets with more shadows and better air circulation, featuring green spaces and green corridors and with an adequate profile and reductions to imperviousness, make the city less susceptible to days with high temperatures and longer heat peaks, as well as resilient to more frequent heavy rains. Other improvements that can make cities more agreeable and tolerable are the encouragement of more 'green roofs' and 'vertical gardens' serving as barrier to high temperatures, as well as the increase of green spaces in the interior of plots and water surfaces in public space (Doherty et al., 2009; Hamin and Gurran, 2009).

HOW CAN WE FIT URBAN FORM INTO MITIGATION STRATEGIES?

Climate change response occurs in two complementary battle fronts, each one with different rationales and expected results: 1. mitigation strategies; and, 2. adaptation strategies. Mitigation was the first approach to achieve scientific and political attention. It proposed the reduction of GHG emissions using two approaches: 1. altering the supply of energy; and, 2. reducing the demand for energy by adopting technology and measures to control the causes of global warming. In this first

FIGURE 8: ↑ Porto, Portugal – inner ring road. SOURCE: Notícias ao Minuto
FIGURE 9: ↓ Porto, Portugal – collective passenger transport (light rail). PHOTO BY: Luísa Batista

FIGURE 10: Porto, Portugal – active mobility modes (bycicle path). PHOTO BY: Luísa Batista

phase of climate change response, the main concern was the substitution of fossil by renewable energy (change energy supply) and promoting energy efficiency in all human activities and urban functions (change energy demand). For many years, these very concrete challenges, directly related to the energy consumption patterns, filled the attention of scientific, technologic, political and media communities. This was the time when the leading role of the international conventions and agreements (mainly in the United Nations framework) proclaimed the urgent need to invest in clean energy and the reduction of energy consumption, both in absolute value and in terms of energy efficiency gains.

As it has been extensively debated in literature (Condon et al., 2009; Ewing et al. 2008; Hamin and Gurran, 2009), the great contribute of urban form to climate change mitigation strategies – creating conditions to reduce GHG emissions - comes from local policy action on land-use and by interventions in urban form elements. Indeed, there is a growing acknowledgement by scientists and urban planning stakeholders that a large part of the global warming challenge may be met through the design of cities and its correspondent development models. The master idea of re-founding cities under a sustainable purpose, which is dependent of a de-carbonization strategy, brings to the table of urban planning a set of urban form attributes relevant to the success of this (mitigation) strategy.

Essentially, the decisive link between urban form and climate change response relates to the required energy paradigm of reducing energy consumption, promoting energy efficiency and the progressive replacement of fossil energies by energies of renewable sources. As always happens, the solutions proposed under this virtuous relationship, considering the energy paradigm transition, also present permanent concerns of ensuring life quality, thermal comfort and urban safety.

Presently, the environmental narrative creates the term 'low-carbon cities' for this model of city, founded on revised transport patterns and alternative land-use patterns which enable lower energy consumption and reduce GHG emissions. These so called 'decarbonized' cities are the opposite of most modern cities which have been designed to accommodate the intense use of the automobile and a strict functional division of urban land. These sprawl cities, with reduced sense of proximity and lower mix of land uses, creates the perfect frame which leads to high standards of automobile use and energy consumption, in general.

The gains obtained by intervening in urban form are, fundamentally, focused in promoting the proximity (real and perceived) and, simultaneously, higher mixes of urban functions (to avoid long displacements to satisfy multiple needs), assuming higher degrees of urbanity, which generally means high accessibility, density, diversity and continuity (Oliveira, 2016). A city-model where those attributes are present in a high degree, together with the promotion of public transport and the improvement of active mobility models, will reveal more sustainable energetic metabolic balances, resulting in decreasing fossil energy consumption and lower GHG emissions. In comparison, city-models based in individual transport use, conditioned by an urban form that increases the distances and the necessity of making trips to satisfy different needs, have less sustainable energetic metabolic balances.

Another aspect of how urban form fits to mitigation strategies is related with the creation or maintenance of green surfaces in the urban fabric (gardens, parks, green-roofs, green corridors, streets with trees, urban farms), considering the role they have in increasing the city's carbon capture capacity. However, it is important to consider that the CO2 sink potential of each green species is different. So, to simply increase green areas, without considering the species, does not guarantee a positive progression in carbon sink.

Additionally, the intervention in urban form elements has the potential to increase climatic comfort. Examples of potential benefits are: a correct solar orientation of buildings; the consideration of normal wind orientation to preserve building and plots; the use of adequate materials considering the local climate; exploring the potential of green surfaces (including green-roofs) and water surfaces in order to temper the urban microclimate, especially heat peaks.

FIGURE 11: Porto, Portugal - building with solar energy. PHOTO BY: Luisa Batista

HOW CAN WE FIT URBAN FORM INTO ADAPTATION STRATEGIES?

Departing from those examples of climate change mitigation measures, we can show another relevant role of urban form – its potential for both mitigation and adaptation. The same mitigation objective to increase energy efficiency by intervening in urban form elements will match some climate change adaptation objectives, namely producing urban form conditions to re-balance the precedent relation between city form and local climate context, considering climate change and thinking in a framework of risks and vulnerabilities.

Local climate change adaptation strategies are based on implementing policies and measures to accommodate those climate effects that are unavoidable, such as temperature and precipitation variation, and solving or minimizing human and economic impacts by increasing urban resilience. The role that urban form could play in this kind of climate change response is particularly linked with temperature and precipitation scenarios and with their most relevant impacts in cities: heat island effect; increased demand for cooling; declining air quality; increased water demand; disruption of quantity and quality of public water supply; increased risk of heat-related mortality, especially for the elderly, chronically sick, very young and socially isolated persons; adverse effects on quality of surface and groundwater; increased risk of deaths, injuries, and infectious, respiratory, and skin diseases; disruption of settlements, commerce, transport, and societies due to flooding; pressures on infrastructures; loss of property; power outages; dis-

FIGURE 12: ↑ Porto, Portugal - Praça de Lisboa (greenroof). Photo by: Miguel Lopes
FIGURE 13: ↓ Porto, Portugal - Praça D. João I (square with problems of bioclimatic comfort). Photo by: Miguel Lopes

FIGURE 14: Porto, Portugal – Jardim da Cordoaria (puclic space with good bioclimatic comfort).
SOURCE: Câmara Municipal do Porto

tress from migration to urban areas; disruption by flood and high winds; permanent erosion and submersion of land; costs of coastal protection versus costs of land-use relocation; potential movement of populations and infrastructure (Hoornweg et al., 2011).

In the medium and long-term future it is already impossible to avoid climate changes (already visible and felt in the present), therefore it has become essential to adapt cities and communities to the new realities (IPCC, 2007; Hamin and Gurran, 2009). Strategies to reduce energy consumption and to increase the use of renewable sources (concerning to mitigation) should be developed in parallel with strategies to readapt cities, adjusting some aspects of their built environment in face of the climatic scenarios and reacting to forecast impacts. The point must be in the awareness that natural context changed so too the cities must change, and urban form will be a relevant component of this transformation, ensuring the maintenance of security, health and comfort. An urban form that became inadequate as a result of climate change can exacerbate climate change risks and communities' vulnerabilities.

In addition to the urban form interventions already mentioned above, we highlight some others equally capable of inducing the adaptation of cities: location of new developments away from risks areas; design of buildings and blocks particularly resilient to heat waves and winds; avoid soils waterproofness and reserve water retention surfaces to better accommodate the impacts of heavy rains; increase green and water surfaces in order temper the heat peaks and the heat island effects; move vulnerable population, infrastructures and facilities away from hazards.

In general, land-use changes and design interventions (of different nature and magnitude) in building, blocks, plots and squares are the main procedures to ensure cities' climate change adaptation.

EXAMPLES OF URBAN FORM THAT CONTRIBUTE TO LOCAL CLIMATE CHANGE RESPONSE

Below, we present a list of examples of urban form measures or policies that could be implemented to mitigation and assist cities to adapt to local climate change response (Dubois et al. 2012; Hamin and Gurran, 2009; Countryside Council for Wales, 2004; Wende et al., 2012). Dealing with local climate change response in these two dimensions requires alertness to the eventual occurrence of what literature, currently, names 'maladaptation'. This term represents the awareness that the implementation of mitigation and adaptation strategies can generate conflicts, in the sense that the option for a certain measure could make unfeasible the reduction of the scope of another measure (for example, the goal of making the city denser may conflict with the goal of create more green spaces) (Hamin and Gurran, 2009).

Also, several urban form interventions can produces results on both dimensions – mitigation and adaptation. This is the cases of measures that improve climatic comfort of buildings and, simultaneously and consequently, contribute to lower the energy consumption for heating or cooling of the same buildings. Others that increase urban shades in public space, by reforestation and tree planting, to cool the urban microclimate, also have benefits to walkers and improve the CO2 sink at the same time.

Measures / Policies	Elements/Attributes of urban form	Adaptation	Mitigation
Protect natural hydrological systems and addition of water surfaces, to cool naturally urban microclimate	Land-use Water surface	•	
Increase urban shades in public space (e.g. reforestation and tree planting programs), to cool naturally urban microclimate and to CO_2 sink.	Land-use Streets Squares	•	•
Increase and maintain spaces for floods and water retention	Land-use	•	
Displacement of constructions (buildings, facilities, infrastructures) from coast zones or flooded areas	Land-use	•	
Preserve open space (public and private)	Land-use	•	
Create buffer zones and growth boundaries (limit suburban sprawl)	Land-use Density		•
Intervention on building design (e.g. urban design requirements) to improve energy-efficiency, minimize energy need and maximize thermal comfort; enable buildings to use renewable energy Integration of adequate and innovative materials in built environment Building codes that require roofing and paving materials that reduce heat island effects (e.g. green roofs, pervious paving systems). Tailor and adapt building design to local climatic conditions (e.g. use natural daylighting and ventilation to avoid artificial light or air conditioning; well-insulated buildings need little energy to keep warm)	Buildings	•	•
Areas and sites for energy supply systems, e.g. facilities for cogeneration, wind turbines, photovoltaics.	Land-use		•
Encourage the construction of smaller homes, at a high-density area	Buildings Density		•
Energy-saving arrangement of housing blocks and flats Low-shade positioning of structures during the winter, and active-constructive shading during the summer.	Building Plots	•	•
Promote high-density and in-fill development through zoning policies Brownfield conversion; Using building stock for emergent need of new housing Discourage sprawl Incentives for development in existing downtown areas and areas near public transit Improve public transport in residential cores	Land-use Density Proximity Accessibility		•
Locate facilities, new residential and commercial developments to reduce travel time and maximize building use Increase mixed-use zoning and diversified economic structures	Diversity Density Accessibility Land-use mix		•
Build cycle paths and keep shops and facilities in walking distance	Proximity		•
Increase permeability of road, bike and walking surfaces	Public space	•	
Improve linkages between different transport modes	Accessibility		•
Traffic calm measures and restrict private car usage	Streets		•

TABLE 1: Examples of urban form contributes to local climate change response

WHY STRATEGIC URBAN PLANNING IS THE SPHERE TO IMPLEMENT LOCAL CLIMATE CHANGE RESPONSE

Spatial planning has an important role in climate change response and is particularly relevant at the local scale, where local governments can establish and implement a climate change response. By the recommendation of the Intergovernmental Panel on Climate Change (IPCC) spatial planning (being evidence-based, interdisciplinary, outcome focused and cross-sector, despite uncertainty) provides a suitable framework to develop an effective response to the complexity, multi-layered and multi-scale nature of climate change issue. It also recognizes that local is the appropriate governance framework to conceive multi-level climate change policies, test their effectiveness and enjoy their successful implementation. The influence of local authorities is evident, considering their ability to alter urban form through urban planning processes and land use regulation. Here is where decisions can be made about alternatives concerning mixed-use, active mobility modes, walkable neighborhoods, transport policies (approaches and investments), energy consuming patterns, green infrastructure, green spaces, and a host of other decisions that can either advance or hinder climate change mitigation and adaptation strategies.

Also at the local scale it is possible to engage all of the elements relevant to the efficiency of a climate change response: 1) local relevant stakeholders (public and private); 2) the set of instruments- plans, projects, programs and policies – to implement it in a transversal way to interrelate all sectors of planning (e.g. transport, housing, infrastructures, ecosystem services); 3) integrate into the process decision support tools and impact assessment tools which enable planners to monitor the implemented strategies, study cumulative and contradictory effects of those strategies and measures, and, 4) produce and provide relevant information to assess choices between different alternatives.

Finally, it must be highlighted that the strategic dimension of urban planning has a decisive role in climate change response, bearing in mind that we are facing a problem whose solutions must have an inherent focus on the future and require a wide scope of issues and spatial scales that are covered by strategic planning. Firstly, in the case of mitigation strategies, the relevance of making a transition to new low-carbon energy is one dependent on decisions and alternative choices of transversal and comprehensive nature, in the sense that its success passes through the interrelation of different policies (and even different scales, from the neighborhood to the metropolitan scale)- that is only possible in the strategic planning scope. Secondly, in the case of adaptation strategies (but also in the mitigation strategies), strategic urban planning provides a key policy lever because it is in the

FIGURE 15: The difficult change in the energy paradigm of urban societies in times of climate change challenge. Cartoon by Riber Hansonn

public policies sphere where climate change response concentrates an important foundation stone related with a certain innovative role, which must precede the private initiative that is, many times, more conservative, both in terms of solutions or in terms of investments. Lastly, a considerable number of decisions related to city development, urban form and land use, relate to the public space design and with regulatory instruments of local built environment.

CONCLUSION

Despite the efforts at international and national levels to deal with climate change challenge, there is a growing credit and consensus among academics, policy analysts and urban planners that a decisive part of climate change response may be lead in the urban planning framework. The urban form, considering its multiple components (tissue, streets, squares, plots, buildings), attributes (density, diversity, accessibility/connectivity) and the direct impact in the energy consumption patterns, assumes a central role in the local climate change response. Urban form, together with other factors (adoption of green technologic solutions; societal behavior facing climate change issue and facing the need to make the transition of the energy consumption patterns), certainly can make a major role to insure that climate policies will succeed.

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INTEGRATING SCIENTIFIC AND INDIGENOUS KNOWLEDGE TO PLAN FOR FISHERIES RESILIENCE IN THE LOWER FRASER RIVER

HEATHER BEARS, JIMMY ALLEN,
DIONNE BUNSHA, MEGAN ROGERS

↑↑ TOC

FIGURE 1: Fraser river. PHOTO BY Remi Castille

OVERVIEW

The Lower Fraser Valley, located in southwestern British Columbia (BC), Canada, has been home to First Nations[1] since time immemorial (i.e., time beyond memory or record) because of its tremendous wealth of natural resources. The Fraser river- the lifeblood of the region – is one of the greatest salmon producing rivers in the world and has acted as a natural conduit for trade and travel. For millennia, First Nations have thrived on the abundance of salmon, as well as other fish, animals, and plants connected to the Fraser ecosystem.

However, in the past 200 years the First Nations have seen significant changes to their traditional territory. First there was the impact from colonial settlement, which began an era of intensive land use. Since then, forestry, mining, agriculture, and urbanization have altered the landscape with the result that old growth forests, wetlands, and many salmon bearing streams have disappeared or been heavily degraded. Salmon stocks have been declining, and adding to the problem, commercial ventures have participated in over-fishing.

Today, another factor affecting the Fraser river ecosystem is expected to cause significant impacts to the Fraser river watershed and, indirectly, the fisheries and other the values it supports. Sea level rise, coastal and freshet flooding, more intense winter storms, landslides, and changing water temperatures and seasonal

FIGURE 2: Salmon Ceremony on Cheam river, a tributary of the Fraser river. Photo by Dionne Bunsha

flows will also impact fish and fish habitat in the near to medium term future. In addition, First Nations communities, fishing grounds, and culturally important sites located right on the shore of the Fraser river, may be impacted by sea level rise, flooding and erosion.

These changes are threatening a way of life, centered on fishing, which is a central part of the First Nations' identities in the region. As a result, many indigenous communities have a strong desire to act as environmental stewards for future generations, and to protect ecosystem functions that support healthy fish and fishing opportunities through resiliency planning.

The Lower Fraser Fisheries Alliance (LFFA) is a voice for the First Nations of the Lower Fraser river. It works collaboratively to manage Lower Fraser fisheries and to support cultural and spiritual traditions for future generations. The Alliance is made up of 30 member-Nations located along the Lower Fraser river, from Tsawwassen to Yale, BC. As local and regional planning efforts begin to consider proactive climate change adaptation strategies, LFFA is doing its part to represent the unique considerations, perspectives, and priorities of First Nations. The Climate Adapt project, described in this article, is a collaborative effort between the LFFA, Zoetica Environmental Consulting Services, and participating First Nations of the Lower Fraser river.

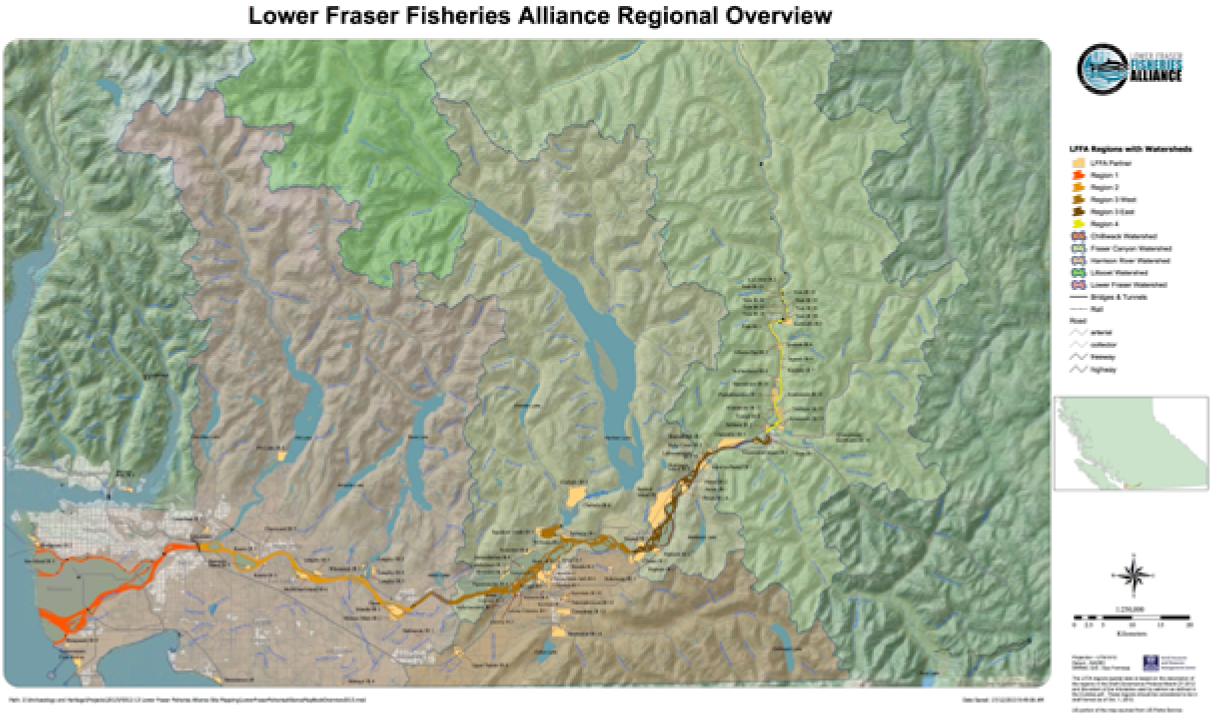

FIGURE 3: The Lower Fraser Fisheries Alliance (LFFA). Regional overview

BACKGROUND

THE FRASER RIVER AND ITS VULNERABILITIES TO CLIMATE CHANGE

The Fraser river is the longest river in BC and sustains one of the world's great salmon fisheries. It flows from the Rocky Mountains to the Pacific Ocean, over 1,375 km in length, and drains a total area of 220,000 km^2. The Lower Fraser begins at Yale, where the river flattens and widens its course, winding through the communities and farmlands of the Fraser Valley, before emptying into the Pacific Ocean at the Fraser river estuary, south of Vancouver. The river transports vast amounts of sediments and has several islands and a large delta. It supports a variety of local wildlife and fish, including all species of Pacific Salmon (Chinook, Coho, Chum, Pink, Sockeye, and Steelhead) as well as Eulachon and White Sturgeon.

The Fraser river has some of the largest Pacific salmon runs in the world, and a wide diversity of other fish species. But in recent years, fish abundance has declined significantly. Chinook salmon, Cultus Lake sockeye, Eulachon, and Sturgeon are endangered. Steelhead and Coho abundances are very low, and are under federal review. Other species of salmon are also exhibiting stress. For example, Fraser sockeye runs can be up to 20-40 million in the highest years

FIGURE 4: Fraser river at sunset. Photo by Jeanne Hughes

of their four year cycle[1]. However, run size is highly variable; in 2016, one of the worst years on record, only 858,000 sockeye returned[1]. In the most recent spawning period of 2017, sockeye salmon returns were also extremely low, with far fewer salmon returning than expected. Other Fraser salmon, such as Chum, appear to be doing well.

As a result of declines in spawning returns, commercial and recreational fishery restrictions had to be put in place and Indigenous fisheries were limited to some food and ceremonial catches. These restrictions mean that salmon runs must have a minimum size to meet conservation targets before a fishery is opened. If a run is opened to fishing, then First Nations food and ceremonial fisheries are supposed to have priority over commercial and recreational fisheries. However, due to the economic importance of salmon and other fish species, these priority restrictions are not always implemented. In a recent study of the economic impacts of Pacific Salmon fisheries, the commercial and recreational fisheries contributed $1.364 billion in Output, $850 million in Gross Domestic Product, $485 million in Labour Income, and provided 12,400 full time equivalent (FTE) jobs to the Canadian economy over the 2012-2015 period (values in USD)[2].

FIGURE 5: Fishers hauling fishing nets. Source: First Nations Fisheries Council

VULNERABILITY TO CLIMATE CHANGE

There are several factors that render the Lower Fraser Valley vulnerable to climate change related impacts. First, the Fraser river valley has a history of rare, but large flood events. The largest flood event occurred in 1894 and was caused by rapid snowmelt[3]. After this flood, a dyking system was constructed throughout the Fraser Valley. In 1948, a second flood occurred. During this event dykes were breached in several places, thousands of people were evacuated, and substantial property damage occurred. Recent estimates of flood risk have shown that the existing dyke design levels, which were established in 1969, are not sufficient to protect against another major flood[4].

Second, the Lower Fraser is one of the most developed urban areas in Canada. It has one of Canada's largest ports, which spurred industrial and urban growth in the region. The continuing urban development in the floodplain increases stormwater discharge into the waterways.

Third, because of land clearing and development, the river and its associated tributaries have lost a great deal of riparian (streamside) vegetation. In some areas, virtually no plants remain. Riparian vegetation provides important benefits by capturing and filtering sediment and contaminants, improving water quality, stabilizing shorelines, and providing shade, nutrients and other benefits for fish. Riparian Areas Regulations (RAR) have been introduced by the British Columbia government to protect watercourses during development[5]. However, buffer strips are sometimes inadequate (5 to 15 m) to function as required. According to a recent meta-analysis, a minimum of 30 m of riparian vegetation is needed to protect small watercourses from temperature fluctuations[6] that are harmful to fish and their spawning grounds.

ENVISIONING A FUTURE CLIMATE

There is a growing consensus that the Fraser Valley will likely experience warmer, drier summers and milder, wetter winters in the near to medium term future. There is also a projected increase of 17% under a moderate climate scenario, the average temperature is likely to warm by 2.5 °C in the summer and 1.4 °C in the winter by the mid-century. This would result in an increase of 17% in winter precipitation and a reduction of 15% in summer precipitation compared to current levels[7]. Sea level is likely to rise by one meter in the next 100 years[8]. Some of the most recent regional modeling for Metro Vancouver, based on the “business as usual” scenario (RCP 8.5), suggests even greater changes, with an increase of 3.7 °C in summer and 2.4 °C in the winter by 2050, the largest increase of precipitation (11%) in fall and a decline in precipitation of 19% in summer[9]. Climate changes by the year 2100 also show a continued warming trend.

A moderate climate change scenario (HadCM3 B1 1) was selected and run in the PCIC Regional Analysis Tool for the Fraser river Basin region for 2040-2069 time period[7]. This scenario envisions rapid economic growth towards a service and information economy, a world population rising to 9 billion by 2050 and then decreasing, reductions in material intensity and the introduction of clean and resource efficient technologies, and an emphasis on global cooperation to solve common challenges. Median projected seasonal climate trends for the region show the following:

· Winter (DJF) ppt: +17%; mean temperature: +1.4 C; snowfall: +9%
· Spring (MAM) ppt: +14%; mean temperature +1.2 C: snowfall:-4%
· Summer (JJA) ppt:-15%; mean temperature: +2.5 C; snowfall: 0
· Fall (SON) ppt: +4%; mean temperature: +2.1 C; snowfall:-28%

PPT: PRECIPITATION

FIGURE 6: Fraser river Valley during wintertime. Photo by Jeanne Hughes

HOW MIGHT FISH AND RELATED ENVIRONMENTAL VALUES BE AFFECTED BY CLIMATE CHANGE?

When planning for climate change, there is often a focus on potential impacts to human health, communities, infrastructure, and/or the economy. This is particularly true in urban areas, and in coastal areas such as Vancouver and the Lower Fraser Valley, where the potential risks to urban areas from sea level rise and flooding are significant. However, climate change is also expected to affect watershed processes on a wider scale, resulting in future physical, biological, and socio-economic changes that will have significant effects on fish and fish habitat.

From the tops of mountain glaciers, winding through rivers to the sea, climate change touches every aspect of fish habitat in a unique way. If we were to see climate change as though we were swimming along a salmon-bearing watercourse, we would observe a complex matrix of interacting factors that directly or indirectly affect fish. We could start at the glaciers and snowy mountaintops, which feed large volumes of cold meltwater into the system every spring (known as the “spring freshet”), and supplement watercourses in drier months. But as temperatures increase, this natural cycle may change. Warmer temperatures over the long term may result in lower snow packs, and reduced volumes of stored water for later in the summer. Warmer springs may also mean faster, more sudden melts of winter snowpacks, which can cause large volume water releases and freshet flooding. In the short term, increased glacial melt may affect water temperature, water chemistry, and may introduce suspended sediments due to higher flows[10]. Over time, glaciers may recede altogether, and these inputs may eventually be lost causing reduced flow, particularly in the summer.

The uppermost reaches of salmon-bearing watercourses usually have the steepest topography. Though they may not all support fish, they provide food and nutrients to fish downstream. Climate change may result in more intense storms and higher volumes of precipitation that increases the risk of landslides, particularly in areas where human activity (e.g., logging) or increased fire and forest pests (e.g., mountain pine beetle outbreaks) have resulted in the loss of tree cover. These events can be devastating for fish and other aquatic organisms, as they send smothering sediment into watercourses, create barriers to fish movement, and strip away important streamside vegetation needed to shade and cool watercourses.

Lower down the mountain slopes, streams begin to moderate in slope, slow and widen. Fish are more plentiful, and the accumulation of gravels and other suitable substrates supports spawning. Much of the spawning activity occurs in the late summer and early fall, when water levels can be critically low and temperatures high. Reduced rainfall in the summer and higher temperatures can combine to deplete oxygen levels, reduce egg survival, increase the risk of disease, and reduce fish productivity. Fish distribution may change as some stocks become displaced or move elsewhere[10]. This could result in competition between fish species, and new or reduced opportunities for fishing. Declines in salmon spawning could also have negative impacts on coastal ecosystems. Many predators such as bald eagles and bears depend on the nutrients provided by salmon[10]; as salmon carcasses breakdown, these nutrients also support streamside vegetation and other organisms.

Salmon have low tolerance thresholds and a 1-2 °C change in water temperature can affect distribution. Cold water fish such as Steelhead, Chinook, and Coho are most susceptible to stream warming (lethal limit of 24, 25, and 25 °C, respectively, for adults and juveniles, and 20 °C for eggs[11]). Sockeye, in particular, prefer colder temperatures than other salmon species and may be the most sensitive to climate change. Exposure to several days of temperatures between 22ºC and 24ºC can be lethal[10].

As we follow these mountain-fed streams into the main stem of the Fraser river on the floodplain, we notice a substantially changed landscape. Past and present development has greatly altered riparian habitat and the river itself. Agricultural, commercial, industrial, and residential activity surrounds the Fraser on all sides. Much of this activity has impacted fish, introducing contaminants, stormwater, and other pollutants into the system. Tree removal, and loss of wetlands, has eliminated a valuable natural filter and shade provider, placing even more stress on the ecosystem. Dykes, pumps, dams, and other infrastructure have been installed to help manage water and floods, again affecting fish populations. Climate change may have some of its most significant impacts in this area. Sea level rise, and more severe winter flooding due to increased precipitation, may require infrastructure upgrades to protect communities, wharves, and cultural sites which may again affect fish habitat. More floods could also result in release of more harmful pollutants from old, contaminated sites that have left a legacy of arsenic, heavy metals, and petroleum within the soils. In the summer, drought may increase competition for scarce water resources, as agricultural producers draw down aquifers linked to the river. Invasive species may become more established as conditions become more accommodating, resulting in competition with native fish and plants. In some cases, invasive aquatic plants will also decrease the quality of fish habitat.

FIGURE 7: Chum Fishing on Harrison river, a tributary of the Fraser river. Photo by Dionne Bunsha

Eurasian watermilfoil is an invasive, aquatic plant that grows in dense clumps in ditches, streams, and lakes. A mass of root fibers firmly anchors the plant to the lake bottom and numerous branching stems reach the water surface, forming of a tangle of growth[12]. At Cultus Lake, surveys have shown that dense patches of Eurasian watermilfoil displaced spawning sockeye from certain areas, and that spawners returned to these areas after plant removal[12]. This invasive species could therefore limit the available spawning area or displace sockeye to less suitable spawning habitats[12].

Finally, as the fish make their way out from the Fraser and into the Pacific Ocean, they will experience normal physiological stress as they adjust to the changing salinity. However, climate change is creating more acidic ocean conditions that may require fish to spend more energy which can negatively affect life processes[13]. Together with additional impacts of shipping, pollutants, and other human uses, there is a significant cumulative effect on fisheries.

While some of these impacts may be difficult to manage or prevent on a regional scale, there will be opportunities to reduce vulnerability, increase resilience, and even improve on the existing state. Choices will have to be made however, and some of them will not be easy.

CLIMATE CHANGE ADAPTATION ACTIONS

While management of some climate impacts, such as receding glaciers or ocean acidification, may largely be out of our hands, there are many instances where action can be taken to mitigate climate change risks at the local scale. These actions fall into one of three general categories: protection from flood risks (i.e., hardening of our defenses), restoration and enhancement (where we look to restore natural conditions that will increase resilience while maintaining human use) or managed retreat from flood risk (removing infrastructure altogether and returning to a natural habitat).

An example of a flood risk protection measure is increasing the height of dyking structures. But these activities can have positive or negative repercussions for fish habitat. For example, higher, wider dykes may reduce the impacts and area affected by large flood events. However, such structures often displace important riparian habitat, as plants and tree roots can potentially weaken dykes and impede maintenance, and are often removed. Furthermore, dyking can straighten channels, alter flow rates, and reduce habitat complexity.

An example of a restoration action is replanting streamside vegetation. Fisheries are particularly vulnerable to climate change impacts on water temperature along spawning streams where less than 30 metres of streamside vegetation is left intact[6]. As water flows will be reduced in spawning streams over the next 100 years during the spawning season, the risk of water temperatures reaching critical or lethal levels will increase. Re-establishing riparian vegetation to 30 m or more, can improve shade and cooling, while also providing value-added benefits such as buffering against water pollution (filtering out pollutants and sediments), and enhancing streamside wildlife corridors. Another example of restoration action is to conduct landslide risk assessments and slope stabilization mitigation above important salmon bearing watercourses, where the headwaters flow through a potential high-risk landslide zone.

In some cases, managed retreat may be favoured where the cost or effort to protect an area for human use far outweighs the benefits, or where letting an area flood would do more good. For instance, in some areas, dykes could be breached to allow flooding, water storage, and the potential re-establishment of salt marshes, salmon rearing habitat, ponds or lakes that once existed, but were lost following post-contact landscape modifications. Managed retreat is often a difficult option to implement in a relatively well-populated area, as land users may prefer a protection option that would allow continued land-use.

THE CLIMATE ADAPT PROJECT

PROJECT DESCRIPTION

The LFFA's Climate Adapt project focuses on providing tools, such as environmental mapping layers and risk heat maps. These tools provide the information to identify priority areas where adaptation/resilience planning is needed to buffer fisheries against the impacts of climate change. While we are unable to address all climate impacts and large-scale processes, our goal is to create a plan to help mitigate the impacts of flooding, water temperature changes, and vegetation changes, thereby providing the most direct route to addressing fisheries-related issues. Improvements in these areas may help to build the resilience of the ecosystem, and buffer against other changes outside of our control.

There are three phases to this project, each building on the previous, from planning through the implementation of adaptation strategies.

Phase 1 (2017- 2018) is underway with the objective of completing a vulnerability assessment to improve our collective understanding of specific hazards and risks related to climate change. Scientific data sets (collected from government and other sources) are being collated and mapped to help identify the areas, values, and infrastructure vulnerable to inland and coastal flooding. This information will then be analyzed and presented as heat maps to provide a picture of relative risks and vulnerability. These maps will act as a decision-making tool for First Nations which, along with their local aboriginal knowledge, can assist them in identifying management priorities and implementing regional planning strategies (Phase 2). The base mapping will also provide an important tool for First Nations to have a voice in other regional climate planning, and land use planning processes.

Phase 2 (2018- 2020) will focus on community-based adaptation planning. First Nation-driven climate adaptation plans will identify risks, opportunities, constraints, and priorities for fisheries management. We will include a tool box of adaptation strategies to respond to potential adverse situations and mitigate their effects, while also finding opportunities to provide benefits to the environment and the people, fish and wildlife that rely on it. Potential adaptation strategies include protection of infrastructure (e.g., dikes, pump houses, wharves), natural areas restoration, and managed retreat.

Phase 3 (beyond 2020) will develop area specific adaptation strategies plans based on identified priorities to protect or restore fish habitat and infrastructure. If recommendations for habitat restoration and flood protection work are implemented by First Nations, the recommendations will result in enhanced capacity, communication, infrastructure and employment in First Nation communities. This phase complements LFFA's Fish Habitat Restoration Initiative (FHRI) project and projects completed by individual First Nations, which assist in on the ground restoration activities, such as planting of appropriately adapted vegetation.

Anticipated benefits of the Climate Adapt Project include:

1. Developing a spatial database to identify areas vulnerable to inland and coastal flooding;
2. Raising awareness of the consequences of inaction in comparison to different adaptation strategies;
3. Creating community-driven climate adaptation plans that allow First Nations to work together proactively to deal with potential impacts of flooding and other climate impacts;
4. Provide a greater voice for First Nations in local and regional land use and flood management processes; and
5. Enhancing capacity, communication, infrastructure and employment in First Nation communities.

PHASE 1 - PROGRESS TO DATE

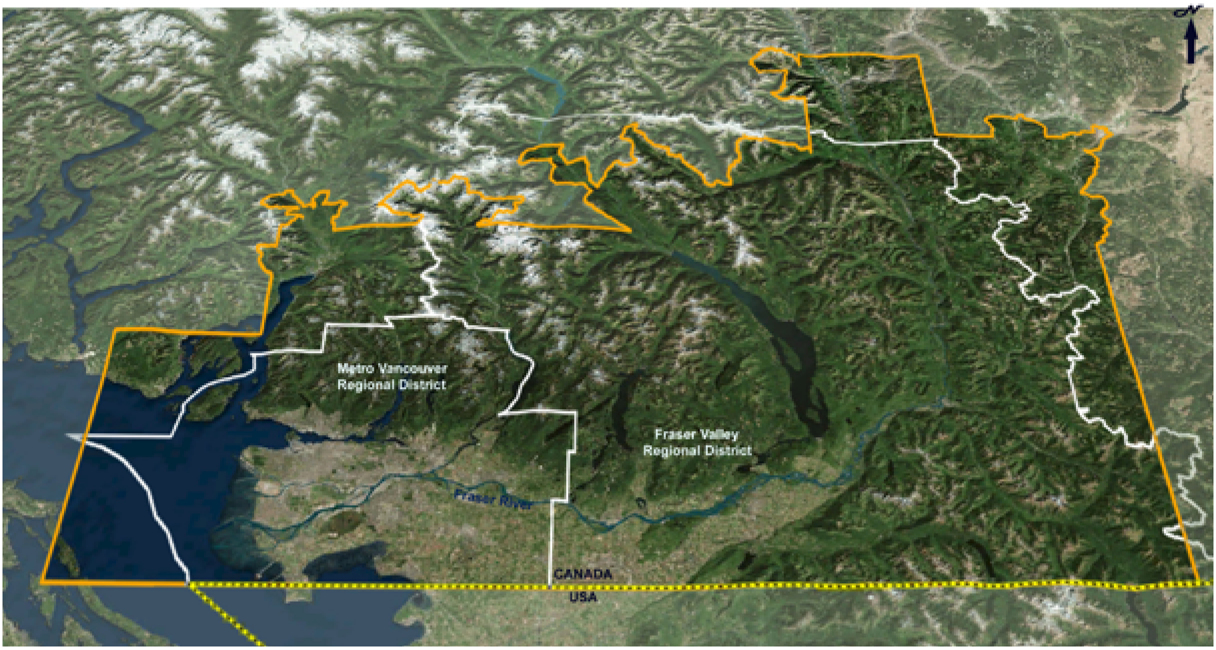

FIGURE 8: Study area

A study area was selected before any mapping began which focused on the Fraser river region considered by the LFFA to include and incorporate the full extent of important fish-spawning tributaries that feed into this river system.

A novel feature of this work was the effort to incorporate traditional First Nation knowledge into the planning process. A list of fisheries-related values was provided to First Nations and they were asked to provide feedback on what should be included as part of the mapping. These values included important habitat (e.g. riparian habitat, spawning and rearing areas, eelgrass beds, etc.), infrastructure (e.g. boat launches, dykes, pump houses, etc.), cultural sites, and threats (e.g., contaminated sites, invasive species, fish barriers, etc.). Relevant information from freely available sources and secured provincial datasets were then collected and base maps were produced representing specific values of concern. These included: sensitive ecosystems, salmon escapement (number of salmon that "escape" capture in the ocean and return to spawn), landslide risk, invasive species, fish presence, and historical fish occurrences. This information was presented to First Nations representatives at an LFFA Climate Forum to incorporate important aboriginal knowledge, feedback, and recommendations.

Climate Forum:

A LFFA Climate Forum was held to introduce the Climate Adapt project to the Nations and begin our engagement process. Key objectives including:

1. Introducing mapping work done on important ecological values related to First Nation fisheries.
2. Viewing Fraser flooding scenarios to understand what could be affected due to coastal and freshet floods.
3. Discussing various options to deal with climate change, including flood impacts.
4. Identifying priorities for adapting to climate change

FIGURE 9: Salmon Harvest. Source: First Nations Fisheries Council

Once base maps are produced, climate change impacts on First Nation Fisheries and flood scenarios will be considered. A Risk and Vulnerability Assessment will then be conducted to assign a ranking of value (relative importance), risk (potential for loss, damage, destruction, or insufficient resiliency), and vulnerability (weakness in protection effort) across the region. Relative value, risk, and vulnerability scores for values across the region will be depicted using heat maps. These heat maps can be overlaid to identify the areas that are most likely to be impacted by climate change or more likely to experience severe impacts. This will enable Nations to observe climate-related threats to fisheries and overlap with aboriginally important infrastructure. Mapping will also aid in the prioritization of proposed adaptive planning; opportunities to restore/enhance fish habitat or mitigate risks such as flooding can be identified at this stage and examined more fully in subsequent phases.

REFLECTIONS ON PHASE 1

While the LFFA Climate Adapt project is still in its early stages, sufficient time has passed to reflect on some of the unique challenges and lessons learned. The scale and scope of the project requires input and cooperation from different First Nations, government organizations, and scientific bodies. This has provided a unique opportunity to bring together different perspectives and ideas to achieve a common goal.

Projects that bring together aboriginal knowledge with "western science" demonstrate that the two need not be exclusive. Rather, they are complementary. First Nations have a historic connection with the land and water. The collective knowledge that has been passed on (often as oral history) can provide important snapshots in time that can complement science by filling in scientific gaps (both historical and present day). This is one reason why elders are so important in First Nations culture; elders embody the past and pass this knowledge to younger generations. Experienced fishers and hunters also have expert knowledge about the areas where they harvest and have been observing changes closely over decades. Their observations and concerns are important while identifying priorities for adaptation.

The LFFA Climate Forum was the first opportunity in this project for representatives of different First Nations to provide feedback on the maps produced based on their traditional knowledge of the area. One of the first comments received was about how the study area boundaries were determined. The Lower Fraser Valley is a large area and determining the spatial extent of the area that should be mapped was an important first step. While defining a study area can help focus efforts, there are some important considerations. First, while mapping, there is often a tendency to use grids or political boundaries to define a study area. However, the natural world does not often recognize such boundaries. Water flows and fish swim, undeterred by lines on maps. Recognizing some of these issues required a different approach. First Nations pointed out that everything is connected; therefore, some project boundaries were altered to follow watersheds that feed into the Fraser river, rather than a straight-line grid system, which was originally presented as a potential study area map.

Many of the maps presented use existing datasets that are incomplete. The study area is large covering thousands of square kilometers and hundreds of tributaries. Limited government resources mean that only a fraction of this area is surveyed, and sometimes these surveys can be out of date. The Climate Forum provided First Nations representatives a chance to confirm or correct some information, in addition to highlighting areas of significance to the indigenous fishery based on their local knowledge. This invaluable process helped fill in knowledge gaps and identify priority areas for management.

The integration of First Nation traditional and ecological knowledge with data collected through other scientific methods was done in several ways, depending on the sensitivity and confidentiality of the information. For non-confidential data, we were able to create data maps that served as reference material, which First Nation representatives could modify. First Nation fisheries representatives identified important areas related to fish health and fish habitat that could be at risk. The number of sites that we asked each representative to identify was limited and set in advance, to gather roughly equivalent input from each First Nation, and to ensure that the highest priority areas were identified. For example, we may show a map of slope and potential landslide risk. A simple scientific analysis may rate the highest risk areas as those with the greatest landslide risk adjacent to the most productive salmon spawning areas. However, First Nation representatives may have different interpretations. They may instead mark areas of known previous slides, or high landslide risk adjacent to unproductive watercourses that were once highly productive, and where restoration effort is already underway or anticipated. Representatives familiar with their traditional territories may also have histories and stories of landslides to draw from, allowing them to point out unique features missed using slope-based risk mapping. Once First Nation information is combined with scientific maps, concordance between the two can be identify high risk areas with greater confidence, whereas non-concordance can allow us to plan more conservatively, defaulting to the scientific or traditional knowledge that warns of the greatest risk.

For confidential mapping layers, however, the process of integrating First Nation input is not so simple. For example, the LFFA has been collecting information on important shoreline features to protect from floods along the Lower Fraser. In many cases, First Nations are reluctant to release such information about important indigenous features, for fear that these areas or their artifacts could be destroyed or removed. Therefore, confidentiality agreements are signed and the spatial data cannot be released beyond the confines of those indicated as being able to view the data. Likewise, the government of Canada and British Columbia also has “sensitive data” layers, which are confidential. Such data may include information on species at risk locations, and sensitive habitat that the government does not wish the general public to visit or exploit.

When working with these sorts of data, the situation is exponentially more complicated. In general, data cannot be shared easily, and must be dealt with on a case by case basis. However, the LFFA, as holders and viewers of information, may be able to use such data as inputs into "heat maps", which are generalized coloured maps that depict risks and values across the landscape that need certain considerations. We have learned that these heat maps must be created with the utmost sensitivity, ensuring that polygons are broad enough to not point to any specific features that could put any confidential First Nation or government data at risk, but still provide enough information to guide future management decisions. Furthermore, recommendations for mitigation and planning for such areas may need to follow more generalized language, such as "protect area from flooding". While onerous from a data management perspective, it is still very important that these data be integrated, capturing needs and risks across the landscape that are not easily shared or viewed in any other way.

First Nations' capacity to engage and be involved in projects can also be an issue. Individual First Nations have limited funds and staff to address a myriad of projects on territorial land. There is a duty to engage with First Nations if projects are to proceed on traditional territory, and for some Nations, this can mean a significant amount of time. The LFFA, who are leading the First Nation engagement portion of the study, has learned that tailored engagement with each First Nation group, which takes these constraints into consideration, may be required to encourage participation.

CONCLUSION

The Lower Fraser region is one of the most populated areas in Canada. The ecosystems in this region are already fragile due to the cumulative effects of urban, agriculture, and industrial development. The importance of climate change and its potential impacts on traditional fisheries has brought together many First Nations who are deeply connected to fishing as a way of life on the Lower Fraser. It is hoped that their involvement will continue to grow and expand over the next few years as climate adaption strategies are developed and implemented to ensure fisheries remain an integral component of a vibrant culture.

ENDNOTE

1 First Nation(s) First Nation is a term used to identify Indigenous peoples of Canada who are neither Métis nor Inuit. It can be uses to refer to a single band or the plural First Nations for many bands. From the Indigenous peoples a guide to terminology https://www.ictinc.ca/indigenous-peoples-a-guide-to-terminology

FIGURE 10: Eulachon fishing. PHOTO by Dionne Bunsha

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PLANNING FOR HEAT RISK IN VULNERABLE COMMUNITIES IN SURAT CITY

LUBAINA RANGWALA, MADHAV PAI

FIGURE 1: Residential street through Kosad Awas a slum rehabilitation scheme in the north zone of Surat city.
SOURCE: WRI India

'The heat that I have experienced in my new home, on the fourth floor of this building, is heat I have never experienced in my life' – explains Hiralal, a resident of Kosad Awas, Surat's massive slum relocation and rehabilitation scheme that is home to more than 19,000 households.

BACKGROUND

Summers in India are sultry, still, and often oppressive. Most Indians, especially those living in central India and inland regions, are acclimatized to high temperatures and have their own traditional practices to manage heat stress and protect themselves from heat-related illnesses. Hence, in most Indian regions heat is seen as a nuisance or an inconvenience, but rarely characterized as a 'life threat'. However, the summer of 2015, broke all records in India. For more than two weeks, several regions across India saw temperatures that were 5.5 degrees Celsius above normal[1]. By the end of the summer months, the death toll from what was recorded as the 'fifth deadliest heat-wave in human history' had risen to above 2,500[2]. This was higher than the number of fatalities from any other natural disaster in India[3] that year. The Indian Meteorological Department predicts that summers in India will continue to show an increasing temperature trend, posing formidable challenges for growing Indian cities[4]. In 2010, heat waves across the nation killed 1,300 people, and in 2013, heat stress related fatalities increased to 1,500.

The 2010 heatwave in India, made extreme heat an important public health concern, and caught the attention of government officials and NGOs. In Gujarat cities, such as Ahmedabad, the average monthly maximum temperatures of 38.8 degree Celsius from March – June increased to 45 degrees C. in 2010. During that period in 2010, the highest recorded temperature was 46.8-degree C. These extreme conditions, resulted in hundreds of heat-related deaths in Ahmedabad, and a significant spike in all-cause mortality.

By 2013, the Indian Institute for Public Health, Gandhinagar (IIPHG), the Ahmedabad Municipal Corporation (AMC), the Indian Meteorological Department (IMD), the Natural Resources Defense Council (NRDC), and other partners developed the first Heat Action Plan for Ahmedabad city. Following this, the IIPHG provided technical assistance and support to expand heat-health action planning across several cities in India, with focused activities in the states of Telangana, Odisha, and Maharashtra.

A majority of the heat wave casualties in India constitute a specific demography of homeless people, outdoor workers like vegetable vendors, auto repair mechanics, cab or auto-rickshaw drivers, construction workers, police personnel, road side kiosk operators, and the elderly largely from economically weaker sections[5]. Poor access to health care and heat-health trainings, the lack of flexibility to diversify work hours and avoid working under high-risk conditions, and the fear of losing employment or income, renders these groups most vulnerable to extreme heat. Despite these concerns, heat waves are still not included in the notified list of natural disasters in India[6], resulting in several cities not following the National Disaster Management Authority's guidelines (issued in 2016) to integrate heat action into the city's disaster management plan.

Most disaster management plans that have not taken adequate measures to assess the resilience needs of vulnerable communities, fail to integrate the numerous challenges and complexities involved in preparing these communities for heat waves. These challenges also defer based on the climatic conditions of a place. While, most cities continue to measure heat risk based on maximum temperature and duration (number of maximum temperature days), studies show that humid heat waves pose a greater threat to human health[7]. For example, in a coastal city at 36 degrees Celsius with a relative humidity of 100%, the heat index is more than 50 degrees Celsius[8] creating a grueling environment[9] especially for poor communities living in underserved and underdeveloped areas of the city.

WRI'S UCRA TOOL MEASURES RESILIENCE AT THE COMMUNITY LEVEL

In 2017, the World Resources Institute (WRI) collaborated with the Urban Health and Climate Resilience Center for Excellence and the Surat Municipal Corporation, to implement WRI's Urban Community Resilience Assessment (UCRA) tool in three urban poor communities of Surat city. The effort focused on the impacts of heat and flood risk in low-income neighborhoods in Surat, while acknowledging 'differential resilience' capacities in different neighborhoods based on unequal access to information, employment, infrastructure and urban services. This project is part of WRI's community resilience work and focuses on developing a process to include the needs of vulnerable communities in city resilience plans. In this article, we will focus on the UCRA findings related to heat stress, and how community members respond to increasing heat stress in their homes and work places.

The Urban Community Resilience Assessment tool, developed by WRI, proposes a bottom-up resilience planning process. This approach is inspired by Cutter's et.al. (2008) 'place-based approach' and focuses on a community's social resilience potentials, alongside infrastructural upgrades, early warning and evacuation communication, and training to enhance personal resilience capacities. It helps cities to quickly and simply identify individual and community scale characteristics using a few indicators by using a methodology that is flexible and customizable to the local context. It integrates a city's resilience strategy or city-level vulnerability assessments, with local neighborhood concerns; linking top-down and bottom-up information systems and resilience actions. Moreover, focusing on aspects of social cohesion, political engagement and economic resources, it aims to use disaster preparedness activities as an entry-point to strengthen social networks and build-back stronger, better prepared and resilient communities.

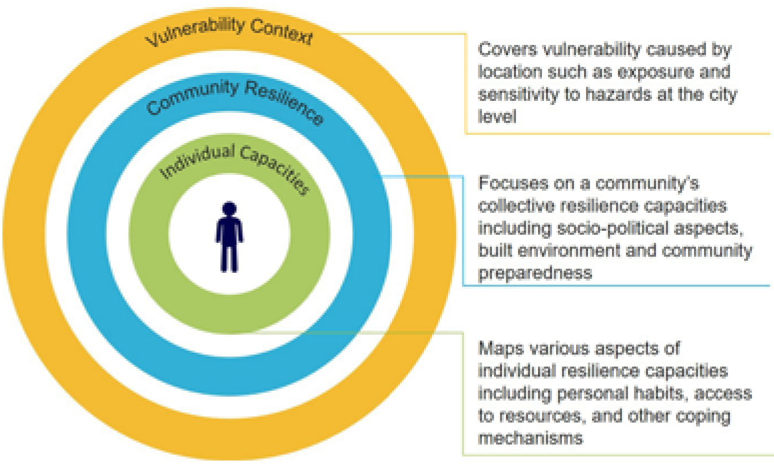

FIGURE 2: The UCRA approach defined by three dimensions

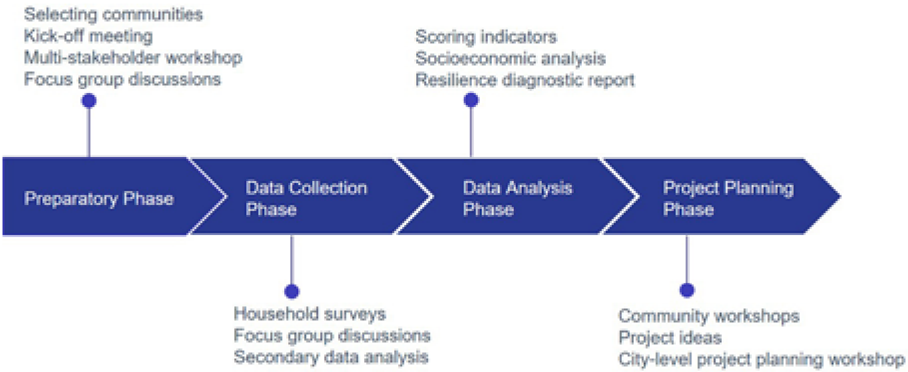

FIGURE 3: The four phased UCRA methodology

The UCRA is framed by three aspects, sub-divided into 10 categories and uses more than 40 indicators. The three aspects are: mapping the vulnerability context at the city level, evaluating collective community resilience potentials at the neighborhood scale, and assessing individuals' capacities to respond to climate risks and extreme events, at the household level. The standard UCRA framework includes the three broad aspects and 10 categories, however indicators are flexible in number and language used to define them, allowing cities to customize the tool as per the local context and climate challenges. While focusing on differential vulnerabilities, the UCRA framework allows resilience planners to identify causal relationships across the different categories and indicators, leading to resilience actions that can address multiple aspects. The tool is implemented in four-phases to: allow cities to customize the UCRA indicators and methodology to a city's local context; collect primary data using household surveys and focus group discussions; analyze and complete the assessment; and share the UCRA results in a multi-stakeholder workshop with community members, city officials and civil society partners to co-develop resilience actions.

SURAT VULNERABILITY CONTEXT

Surat city, located in the state of Gujarat on the floodplain of the Tapti river, is currently home to 5 million people, and covers an area of 327 square kilometers[10]. The city's population has approximately doubled every ten years, making Surat the fourth fastest-growing city in the world[11]. Since 1950 migrant workers, attracted by the diamond and textile industries, poured into the city's slums along the floodplain of the river[12]. The arrival of these migrants created a complex social fabric populated by different regional, religious, linguistic, and caste identities. By 2013, Surat's migrant population was the highest in India, at 58% of the total population[13].

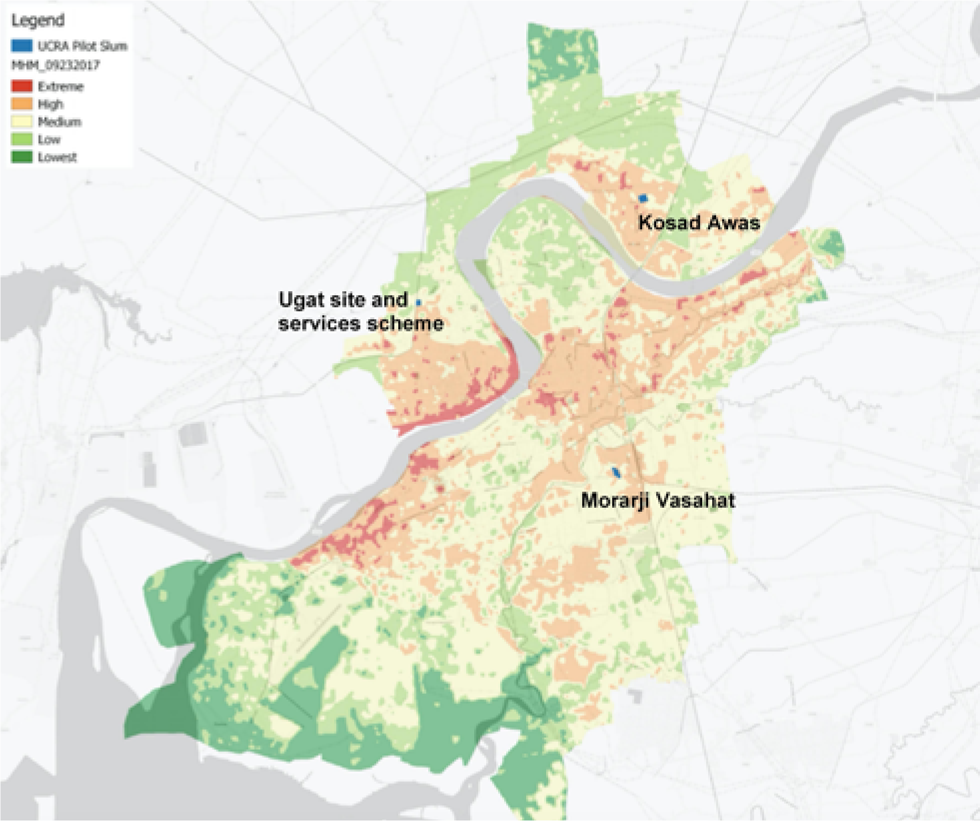

FIGURE 4: Multi-hazard map for Surat city showing high to low risk areas. Source: WRI India

The vulnerability context of Surat[14] shows that 36% of the city's population resides in areas at risk of high air pollution, historic river flooding, and high surface temperatures, meaning that this population scores low on the UCRA resilience scale. The summer heat index for Surat shows that the city is highly exposed to heat stress. The number of summer days when the temperature exceeds 40 degrees Celsius has been increasing almost every year, over the past 10 years.

Eleven percent (11%) of the city's population is either homeless or living in slums and squatter settlements. In terms of social vulnerabilities, 88% of the population is literate and 41% citizens are dependents (above 65 or below 15 years of age), which are both relatively high trends. However, 58% of the population are migrants and the sex ratio is 756 women/1000 men, much lower than that of India.

Ninety five percent (95%) of the city's residents have access to basic urban services such as, water supply, adequate sewage treatment, electricity, and household waste collection. Fifty nine percent (59%) of the city is served by adequate storm water drainage and 52% of the city has access to public transit networks; and in terms of access to health amenities, the city has an average of 25 hospital

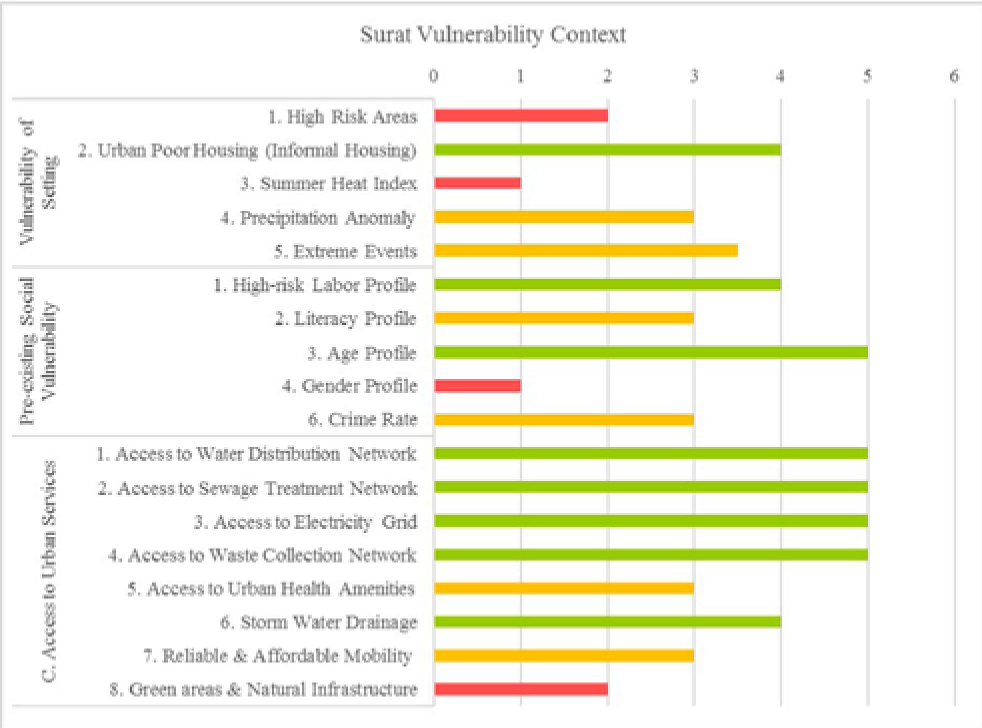

FIGURE 5: UCRA vulnerability context indicators for Surat city with scores

beds per 100,000 citizens. However, every neighborhood in Surat has an urban health center that ensures safe and affordable basic healthcare to all, especially for poor communities.

EXPLORING DIFFERENTIAL VULNERABILITIES IN SURAT

To implement the UCRA in Surat, and capture differential vulnerabilities across neighborhoods in the city, we selected communities living in different kinds of low-income housing with varying access to urban infrastructure, basic services, and political leadership. We found that, while the city scored well on urban services and amenities, poor residents had compromised or inappropriate access to services, impacting their resilience capacities. Moreover, since the city is exposed to two climate risks – flood risk and heat stress – we investigated about how poor residents' resilience capacities are further challenged and compromised by inadequate, inappropriate or lack of urban infrastructure. We selected three communities: *Morarji Vasahat, the Ugat site and its services, and Kosad Awas.* These places are located in different zones of the city, represent different housing settlements with differing access to infrastructure and services, and differ slightly in socio-economic characteristics.

FIGURE 6: Street through the Morarji Vasahat slum community, showing elevated plinths and high doorway thresholds. Source: WRI India

Morarji Vasahat is an old slum located in the South zone of the city. Most residents in Morarji have lived there for more than 30 years, and therefore are socially cohesive. The South zone is the industrial area in Surat with several textile industrial estates that employ slum community members within the area and from afar. Residents live in semi-permanent structures, mostly ground or ground + 1-storeyed, with metal roofs.

FIGURE 7: Street through the Ugat site and services scheme where residents are paving their own street before the monsoon. Source: WRI India

Ugat site and services scheme is a newer settlement located in the west zone of the city, in a peri-urban setting. Residents were allotted plots of land, 13 years ago, and were given basic services (water, sanitation, and electricity). They built their own homes as semi-permanent structures with metal or asbestos roofs. The west zone is a newly developing area of the city, with poor infrastructure and urban services; with similar challenges, as those identified in the settlement.

FIGURE 8: Street through Kosad Awas, showing stark buildings with few trees. Source: WRI India

Kosad Awas is a massive slum relocation and rehabilitation scheme, located in the north zone of the city. Residents from various slum settlements in Surat were relocated there into 4-storeyed, concrete, walk-up apartment buildings, within the last 6 years. Residents have access to basic services, although the allotted apartments are small, overcrowded, and have poor light and ventilation.

The UCRA implementation in Surat included 513 household surveys across the three communities and 12 focus group discussions, of which 6 were segregated by gender and age. Table 1 includes a summary of the geographic and socio-economic comparison of the three low-income communities.

FIGURE 9: The Surat survey team conducting household surveys. SOURCE: UHCRCE

TABLE 1: Description of the three communities where the UCRA was implemented in Surat

Characteristics	Morarji Vasahat	Ugat Site and Services	Kosad Awas
Location:	South Zone	West Zone	North Zone
Population:	5,920	3,255	26, 578
No. of households:	1184	651	19,000
Survey sample size:	167	171	175
Sex ratio:	54 W: 46 M	55 W: 45 M	56 W: 44 M
% dependents – less than 18 years):	33%	41%	38%
Unemployment rate:	4%	4%	3%
Average family size:	4.69 persons	5.04 persons	4.26 persons
Family Type:	59% Nuclear	60% Nuclear	68% Nuclear
Migrants from:	Gujarat, Maharashtra	Gujarat, Uttar Pradesh	Uttar Pradesh, Orissa
Duration of stay in current home:	59% have lived here for more than 30 years	51% have lived here for more than 12 years	77% have lived here for less than 6 years
Home ownership:	83%	77%	59%
Bank account owners:	50%	44%	43%

HEAT STRESS AND RESILIENCE CAPACITIES IN SURAT'S POOR COMMUNITIES

	Morarji Vasahat	Ugat Site & Services	Kosad Awas
A. RISK PERCEPTION AND IMPACTS OF HEAT STRESS			
Increase in heat over the past few summers:	84%	79%	72%
Impact of heat stress on residents' work:	54%	53%	47%
Inability to work due to fatigue and dizziness:	43%	33%	32%
Loss of income due to heat stress:	42%	49%	55%
Impacts of heat stress on residents' health:	34%	29%	25%
B. BUILT ENVIRONMENT CHALLENGES			
Type of construction:	86% live in semi-permanent structures	59% live in semi-permanent structures	100% live in permanent structures
Building materials used:	89% cement walls 34% asbestos roofs 60% metal roofs	77% cement walls 18% asbestos roofs 56% metal roofs	Concrete apartments with one window
Ventilation:	97% adequate ventilation; 39% only have ventilators \ for air circulation	65% adequate ventilation; 47% only have ventilators for air circulation	100% adequate ventilation of one window in front of the main door
Drinking water:	70%: indoor taps	70%: indoor taps	96%: outdoor taps
Access to shaded refuge areas:	79% reported no shaded spaces to sit	99% reported no shaded spaces to sit	97% reported no shaded spaces to sit
C. COMMUNICATION AND AWARENESS			
Receive an early warning system:	23%	12%	6%
Would like to get early warning alerts?	85%	91%	85%
How do you receive weather information?	77%- Television	69%- Television	74%- Television
D. HEAT & HEALTH RESILIENCE			
Receive weather related health trainings:	47%- Yes	65%- Yes	74%- Yes
Who promotes health awareness in your area?	32%- Anganwadi 41%- Urban Health Centre	42%- Anganwadi 35%- Urban Health Centre	29%- Anganwadi 42%- Urban Health Centre
Access to health insurance:	6%	8%	14%
Access to cooling systems:	5%- ACs/ Coolers 25%- refrigerators	3%- ACs/ Coolers 23%- refrigerators	2%- ACs/ Coolers 14%- refrigerators

TABLE 2: Summary of results for the three communities in Surat

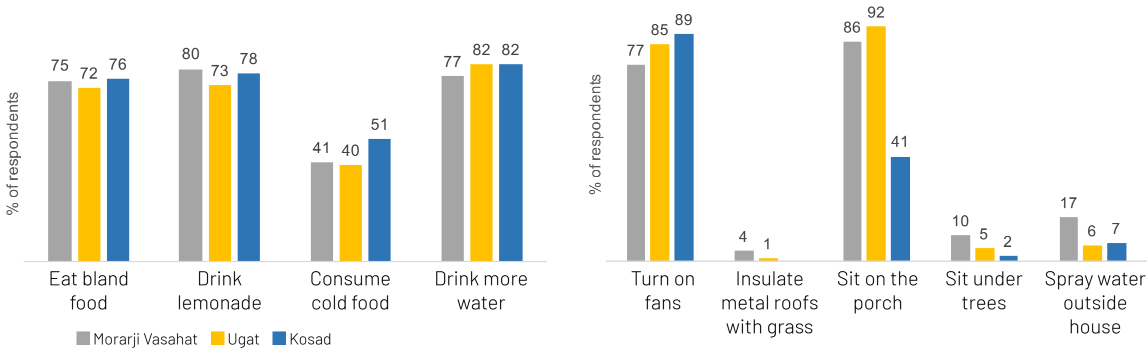

FIGURE 10: Personal resilience habits that people employ during extreme summers; people make dietary changes (left), and increase their comfort levels, while in the house (right)

The UCRA implementation in Surat revealed that while community members saw heat stress as a climate risk, their responses were intuitive and reactionary, and not collectively planned as those for flood risk. Seventy five percent (75%) of the respondents experienced severe or recurrent health impacts due to extreme heat and waterlogging, and 63% of the respondents reported losses in income or livelihoods due to extreme climate events. Even then, community members lacked the information, awareness and access to climate resilient systems and infrastructure to withstand increasing risks.

This section of the paper discusses the UCRA findings related to heat stress, summarised in Table 2 and identifies three key themes for resilience actions.

LACK OF COLLECTIVE HEAT RESILIENCE RESPONSE

Community members expressed a fear of climate change and responded to perceiving heat stress as a threat to their income, employment and personal health. However, most of the resilience measures adopted were intuitive and unplanned. Residents simply drank more water, ate bland and cold food and sat outside to escape indoor heat rather than collaborating on long-term measures like planting trees or arranging heat-related awareness trainings. In Morarji Vasahat, the temple trust is an active community-based organization that collaborates with the area's anganwadi (community center) to manage extreme floods and evacuation measures. However, due to poor awareness and access to information regarding the impacts of heat risk, residents receive no local support during heat waves. Moreover, since most respondents were employed by short-term contracts, and expressed a fear of losing their income or employment, they do not have the options to manage their work timings during extreme heat days. Hence collective heat measures may require engaging varied actors like worker unions, contractors, business owners, and civil society groups to increase awareness regarding heat risk.

FIGURE 11: Comparing Kosad Awas a newly built slum rehabilitation scheme, with stark buildings and few trees, and Morarji Vasahat, an old slum community where people sit out on their porch to escape high indoor temperatures. SOURCE: WRI India

FOCUSING ON THE BUILT ENVIRONMENT

In Kosad Awas, residents live in 4-storeyed apartment buildings with better ventilation, that is, all homes have cross-ventilation with at least one window on the wall across the door. However, the community is constantly in flux. With new migrant families moving to Kosad as tenants, lack of stable employment options, and poor access to the city, the neighborhood has a high frequency of petty crimes. During focus group discussions with women residents, women shared a fear of leaving their windows open during the day when they were alone at home. Most women shared that they prefer staying cooped-up in their homes, even during extremely hot days, to avoid “unpleasant or unsafe encounters”. This results in extremely high indoor temperatures, impacting residents’ health and quality of life. Moreover, due to flat terraces above all buildings, residents shared increased indoor heat temperatures on the fourth-floor of all buildings. In Morarji Vasahat

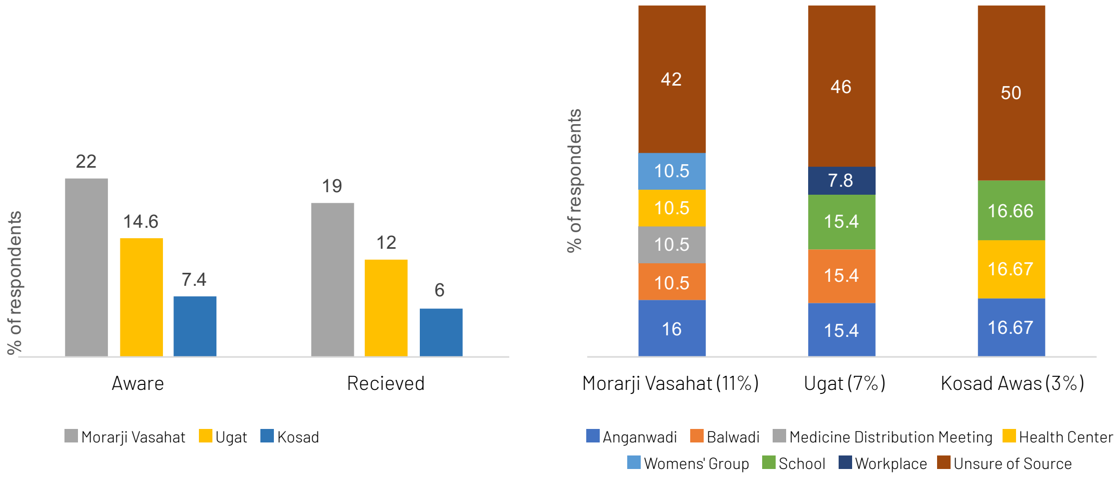

FIGURE 12: Graph showing the percentage of respondents who are aware of the city's early warning system and receive early warning alerts from the city (left); and (right) showing the sources from whom people receive health related alerts and awareness messages

and Ugat, residents live in homes with asbestos or metal sheet roofs, resulting in high internal heat. With increasing temperatures, the city will not only have to focus on the built environment to reduce the urban heat island effect by regulating building materials and introducing more urban greens, but also design safer and healthier low-income housing.

HEALTH AWARENESS CAMPS AND TRAININGS TO ENHANCE RESILIENCE

Surat city has a well-connected network of anganwadis (community centers) in low-income neighborhoods, and urban health centers across the city. The anganwadis and health centers hold health awareness camps, trainings, and share necessary information. For example, most residents said the weather-related health awareness they receive regarding vector borne diseases or other health impacts of extreme climate events comes from the anganwadis or the health centers. Hence, these existing programs can be leveraged to increase awareness on heat risk, its impacts under different conditions, and the kinds of collective and individual responses people can adopt. Moreover, most residents did not have access to health or life insurance, increasing their economic risk and burden on their personal and household health.

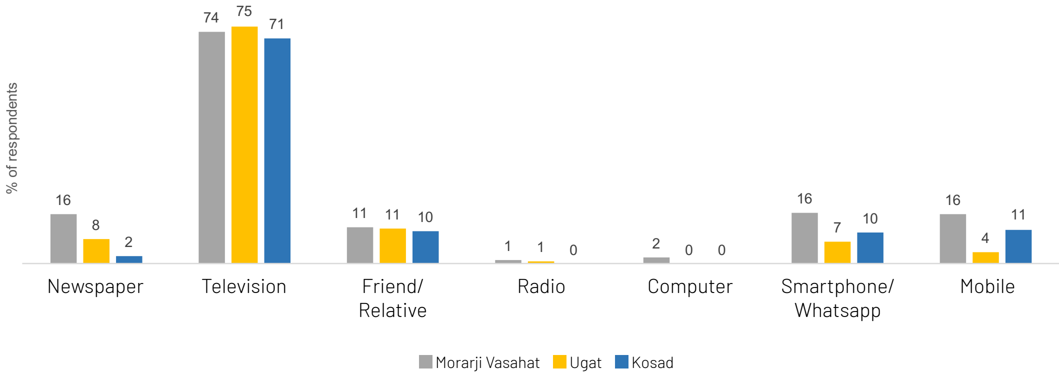

FIGURE 13: Modes of communication most often used by respondents to get their news, early warnings, and awareness messages

CONNECTING EARLY WARNING SYSTEMS TO VULNERABLE COMMUNITIES

Even though Surat has an early warning system, which is a mobile-app based information communication technology, most residents received early warning information and weather alerts through televisions and word-of-mouth. However, this information can be inaccurate and often is responsible in spreading hysteria among poor residents with weak access to proper information channels. Most residents, 85% in Morarji Vasahat and Kosad Awas, and 91% in Ugat said they would benefit from official early warning alerts. In terms of health awareness, residents said they received alerts and training to better manage health impacts from the local anganwadi and community centers. Hence, cities can use UCRA findings to improve their early warning alerts, cater precautionary warnings and other preparedness measures to match the challenges faced by poor residents, and disseminate the information through modes used by poor residents. For example, more than 70% of the respondents across the three communities owned televisions. The opportunity exists to have news channels, or local cable TV operators, run awareness campaigns and warnings during emergencies.

PARTICIPATORY PLANNING TOWARDS HEAT ACTION

The UCRA findings were presented to community members in gender and age segregated workshops to discuss gaps in information, awareness and responses to heat risk, and to identify key resilience actions. Simple measures were discussed like: white-washing their terraces in Kosad Awas or insulating metal and asbestos roofs with layers of jute or terracotta tiles to reduce indoor temperatures; and, introducing trees and urban greens along main roads. Community members also discussed ways to introduce climate resilience and health trainings as part of existing health awareness drives, improve end-user connections for

FIGURE 12: Community workshops in Morarji Vasahat (left) and Kosad Awas (right) segregated by gender, discussing evacuation routes, flood risk alerts, and issues of safety and security among other resilience challenges.
SOURCE: WRI India

the city's existing early warning system, and how to introduce skill development and vocational trainings in newly resettled communities to restore positive social relationships.

While these were simple, cost-effective and conventional measures to reduce heat stress, community members were hesitant to invest in "climate-proofing" their infrastructure and built-environment. Hence to support community resilience efforts, cities must develop resilience strategies that help close infrastructure, service delivery and regulatory gaps in poor communities. Moreover, local needs and challenges must be reflected in the city's annual budget, and implementation partners working across planning scales must help strengthen these linkages using tools such as the UCRA.

Finally, a multi-stakeholder workshop was hosted with the Surat Municipal Corporation. This meeting was attended by city officials from various departments, civil society partners and community members. The attendees participated in a discussion on heat and flood risk, to methods to bridge the two issues. Stakeholders identified four recommendations on heat risk that may be integrated with Surat's heat and health action plan to enhance community and individual resilience to heat risk in Surat.

1. 'Climate-proof' areas by introducing a greenbelt around high-heat emitting land uses such as industrial complexes;
2. Use heat-resistant paint or white-washed metal roofs/terraces to reduce indoor temperatures, and utilize more heat-specific construction in the form of higher ceilings, local materials, fewer glass facades, and more openings for the movement of air;
3. Train nurses and doctors to deal with heat strokes, and other health impacts exacerbated by extreme heat. Moreover, train hospitals to collect data on heat related fatalities, and the increase in all-cause mortality during heat waves and periods of above average temperatures.
4. Increase the capacity of active community-based organizations such as the Residents' Welfare Association, Hamara Bachpan and women's trusts to circulate heat protection and safety messages.

These recommendations, along with others on flood risk were submitted to the Surat Municipal Corporation, to be introduced in the city's resilience strategy, and inter-departmental plans related to public health, waste management, and disaster preparedness.

BENEFITS OF ADOPTING A COMMUNITY RESILIENCE APPROACH

Most resilience strategies or disaster management plans issued by the government are top-down, institutionally driven plans that result in technical, engineered resilience solutions. A bottom-up resilience planning process focuses on people's resilience capacities, their social networks, and abilities to retain employment, income, and social safety. By measuring differential vulnerabilities, needs and aspirations in poor communities, and sharing this information with community members and city officials, a potential for linking top-down city-level risk reduction priorities with bottom-up community level needs, risk experiences and planning aspirations, emerges. Moreover, tools such as the UCRA provide cities with a viable methodology to integrate a participatory and inclusive planning process and a database of resilience actions that community members are already investing in. Even when poor communities are engaged in the planning process, cities lack adequate monitoring systems to evaluate whether community members are receiving the required information and help during the response and recovery period. Therefore, a tool like UCRA is also useful in identifying gaps in a city's disaster management protocol, by quantifying various factors: such as whether early warning alerts are reaching vulnerable citizens; whether the information is considered to be useful; and, whether the mode of communication was effective.

SUMMARY

Our pilot project in Surat focused on flood and heat risk; and while, community members have adopted collective flood preparedness measures, their awareness and responses to heat risk focus on individual habits and personal health precautions. Heat stress is characterized as a 'slow moving climate disaster' that is 'invisible' in its impacts on people and public life, hence responses to heat risk are rarely collectively planned. However, over the recent years several cities in Gujarat (Ahmedabad in particular), Odisha, Maharashtra, and Telangana among other states, are developing city heat action plans to increase awareness around heat stress, mobilize diverse stakeholders and institutions, and undertake long-term actions to address heat exposure at the city level. Some of these include: adopting climate sensitive urban design principles to reduce the effects of heat islands in existing neighborhoods. Mobilizing health awareness through campaigns, trainings and the network of health centers to make heat stress a public health concern. Mobilize employers, contractors and labor unions dealing with high-risk labor like construction workers, to ensure income protection and reduced work-hours during periods of extreme heat. When vulnerable communities are consulted and included in the planning process, heat resilience actions are timely, appropriate and sensitive to their local needs. In conclusion, a community resilience approach, leverages individuals as 'allies' in the resilience planning process, rather than 'victims' of climate disasters.

ACKNOWLEDGEMENTS

This work is part of a WRI project and would not be possible without support and guidance from the Cities Alliance Joint Work Program for Resilient Cities, where the project team pilot tested WRI's Urban Community Resilience Assessment tool in three cities – Rio de Janeiro in Brazil, Surat in India, and Semarang in Indonesia. The project team included Lauretta Burke, Senior Associate, WRI USA, Katerina Elias-Trostmann, Research Analyst, WRI Brazil, Retno Wihanesta, Research Analyst, WRI Indonesia, and myself, with incremental support from a team of consultants and interns. I want to particularly thank Mandakini Chandra, Research Consultant, WRI India, for her support in researching heat risk in India, which has been critical for this paper and our work on heat risk going forward. Our partners in Surat – the Urban Health and Climate Resilience Centre for Excellence – led the local community engagement process in the three low-income communities in Surat. Thank you for all your support and collaboration.

ENDNOTES

1 NASA Visible Earth, 2015

2 ibid

3 Patil, 2017

4 Mavalankar, 2018

5 Patil, 2017

6 Ibid

7 Oldenborgh, et al., 2018

8 Ibid

9 Desai, et al., 2015

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PEOPLE, PLACE, PARTNERSHIPS, SUSTAINABILITY AND RESILIENCE

DOUG FOTHERINGHAM

FIGURE 1: Port Denison Inlet

INTRODUCTION

The Australian Government is committed to taking strong domestic and international action on climate change, and is a party to the Paris Agreement.[1] This historic global agreement, adopted by the United Nations Framework Convention on Climate Change at the 21st Conference of the Parties in Paris (held 30 November to 12 December 2015), set in place a durable and dynamic framework for all countries to take action to mitigate climate change starting in 2020, by building on existing international efforts in the period up to 2020. This means that Australia has committed to improve its approach to:

- Environmental sustainability, in order to mitigate the process of climate change; and
- Resilience, to adapt to, and build the capacity to recover quickly from, the impacts of climate change.

One way for Australia to improve its approach to sustainability and resilience is to develop place-based strategies. Placed-based strategies have been adopted internationally, and in Australia can be applied within both city and regional contexts.[2] In order to be successful, place-based strategies utilise local human capital (people) and innovative methods to grow communities in sustainable ways, while reducing dependency on higher levels of governance, such as state governments.[3] Local governments, and the communities they serve, can play significant roles in developing and implementing place-based strategies.

This article is about the people in a small but resourceful regional community who have strong attachments to the place in which they live and a thriving capacity for volunteering and partnerships. It is also about the way a small but innovative local government utilised community engagement and created strategic partnerships to help the community develop place-based strategies to improve climate change related environmental sustainability and resilience. This was achieved by developing:

1. A Green Infrastructure Strategy; and
2. A Coastal Hazard Risk Management and Adaptation Plan.

PEOPLE, PLACE AND PARTNERSHIPS

Located 369 kilometres north of Perth, Western Australia, within a semi-arid zone, there is a small regional community where the concepts of volunteering and partnerships flourish and provide fertile ground for developing self-sufficiency and innovative capacities. This community of around 3,600 people mostly live in the twin towns of Dongara and Port Denison, within a local government area known as Shire of Irwin. The towns straddle opposite banks of the Irwin River,

FIGURE 2: Dongara - Port Dension

and are wedged on the coastline between the vast agricultural lands of Western Australia's wheatbelt to the east and the even vaster Indian Ocean to the west. The main street, Moreton Terrace, is lined with Moreton Bay Fig trees which were planted in 1906 and are now a focal point of the Dongara town centre. Port Denison's small fishing harbour and foreshore provide another focal point much-loved by the community. Most local families in this community have at least one member working as a volunteer in a diverse range of organisations such as emergency services, health services, local charities, commerce, arts and crafts, sports clubs, place-making, and environmental management.

The Shire of Irwin (the Shire) is the name of the local government organisation responsible for administering the twin towns and their rural hinterland. By local government standards, the Shire is a relatively small organisation, with a modest ratepayer base and a workforce of around 30 full-time officers. The organisation operates within fairly tight financial constraints and with limited access to professional services. For example, during the period between 2008 and 2017, the Shire had no professional engineering, environmental management or sustainability officers on staff. In order to compensate for the lack of professional services, the organisation strongly encourages it's officers to participate in cross-functional projects, fosters a culture of innovation within and across the

FIGURE 3: Irwin River

organisation's departments, and supports partnerships with the community and other organisations[4].

Up to 2014, the approach to environmental sustainability had been managed in a relatively uncoordinated way through the Shire's various functions, including the Tidy Towns Sustainable Committee (TTSC)[5] and its associated volunteers, who had a track record of working successfully with the Northern Agricultural Catchments Council (NACC)[6] on revegetation projects and the like. In 2014, the Shire's planning team recognised the need to improve the organisation's approach to sustainability and resilience by developing a place-based strategy designed to be implemented by the community's willingness and capacity for volunteering and partnerships. The TTSC with its volunteers and NACC proved to be crucial to what happened next.

GREEN INFRASTRUCTURE STRATEGY – SUSTAINABILITY/MITIGATION

The Shire's planners identified the need to develop a Green Infrastructure Strategy as the best way to improve the organisation's approach to sustainability. We carried out the research for the strategy, which included reviewing state, national and international best practice, and began to work out how green infrastructure principles could be applied within the Shire's context. Then a cross-functional team from the Shire visited the City of Vincent Council and met with a Sustainability Officer to better understand their successful 'Greening Program' from a planning and implementation perspective. From this effort, a simple, brief draft strategy was developed in-house by Shire Officers, which incorporated a vision, strategic aims, objectives, policies, and an action plan. This work was presented to the TTSC. On receiving support from the committee, the strategy was presented to Council, who agreed to publicly advertise the strategy.

To advertise the strategy, copies were sent to state government agencies for comments and to other local governments, across Australia, the United States of America, and Europe, that were known to have prepared and implemented similar strategies or which had made significant steps towards mitigating the impacts of climate change. As a result of this process, we received valuable advice and ideas. For example, the town of Feldheim, Germany[7], provided the Shire's planners with some very useful information regarding their approach to environmental sustainability. Importantly, NACC, the Western Australian Local Government Association (WALGA) and the State Government's Department of Water (DoW) were very enthusiastic about the draft strategy and provided insightful comments which helped shape the final document.

In 2015, the Shire's Council adopted the revised final version of the strategy

FIGURE 4: ↑ Moreton Terrace Tree
FIGURE 5: ↓ Port Denison Foreshore.

and the TTSC resolved to play a leading role in implementing the action plan. NACC and WALGA also agreed to be supporting partners and DoW agreed to continue to assist the Shire by providing guidance.

The strategy describes Green Infrastructure as a network of green spaces and water systems that deliver multiple environmental, economic and social values and benefits. The strategy's vision states 'the Shire of Irwin is underpinned by an infrastructure framework that supports a healthy environment and enables our community and economy to grow in sustainable ways'. Over a period of five years the strategy proposed the development of an improved integrated network of multifunctional green spaces and corridors, underpinned by easily maintained, economically and environmentally sustainable engineering solutions. The strategy intended to reducing water and energy consumption by implementing efficient and innovative systems, projects and initiatives.

The Green Infrastructure Strategy is dynamic and multifunctional, in that it provides a strategic vision and direction that supports the Shire's purpose, while providing an evolving policy framework to guide land use and development, water use within public parks and tree planting along streets. It also raises awareness of the impacts of climate change and of the value of implementation actions that improve environmental sustainability. The strategy enables the Shire's different local

FIGURE 6: Revegetation project

government functions to work together in consistent ways, avoiding duplication of effort. It also assists the Council to target resources in the right places at the right times. In addition to this, the strategy acts as a kind of marketing tool for the Shire that has the potential to attract external funding for projects. It also enables community volunteers to take ownership of environmental improvement projects, which make the Shire a more attractive and sustainable place to live, work and play.

The strategy has been embraced by the community, and to date the Tidy Towns volunteers have assisted the Shire with implementing the action plan by:

FIGURE 7: Point Leander Tree Planting

- Taking part in the Point Leander Drive Verge Planting Program to help the plant 100 street trees;
- Carrying out revegetation projects at a popular coastal camping spot called Cliff Head and along the banks of the Irwin River;
- Producing:
  - Advice notes on local pest plants;
  - Advice notes for Integrated Weed Management Plans;
  - Smart Living Guidelines, to assist people live environmentally sustainable lifestyles.

COASTAL HAZARD RISK MANAGEMENT AND ADAPTATION PLAN – RESILIENCE / ADAPTATION

Western Australia's coastal zones are vulnerable to adverse impacts from inundation and erosion. As a result, the Western Australian State Government's Department of Planning (DoP) has established the Coastal Management Plan Assistance Program (CMPAP). This program funds the development of strategies and management plans for coastal areas that are, or are predicted to become, under pressure from a range of challenges, including those created by climate change. Risk to the coastal environment from climate change is influenced by the level of preparedness and response of the community and its recovery capacity. The

FIGURE 8: South Beach Port Denison

plans developed through CMPAP aim to maximise the utility of environmental, social and economic coastal resources and to enhance the resilience of coastal communities to coastal hazards.

By 2015, a number of local governments in Western Australia were using CMPAP funding to develop Coastal Hazard Management and Adaptation Plans (Coastal Plans) based on consultants preparing coastline modelling and stakeholder engagement. Over the years, the Shire had submitted a couple of unsuccessful funding applications. One of the requirements for the funding application was to submit a detailed project brief, which had proved difficult for the Shire, as there were not enough financial resources to employ qualified engineering, environmental or sustainability officers.

The success of the Green Infrastructure Strategy partnership, the Shire's planners began to look for potential partners for the next round of funding applications. We discovered that Curtin University's Department of Engineering was looking for a local government to provide funding for a Master's student to carry out a coastal hazard mapping project as part of their course thesis. From this arose the idea of form a joint venture to submit a funding application with Curtin University. Around the same time, we were able to secure the aid of NACC as well. With the assistance of professional services provided by Curtin's Engineering Department and NACC's environmental sustainability professional services, the grant application was suc-

FIGURE 9: Irwin River Estuary

cessful. Additionally, DoP agreed to provide some technical support, which enabled the Shire and partners to proceed with the Coastal Plan project.

To begin the project, Curtin University carried out a literature review, collecting and reviewing all available information. The literature review included topics such as: state government policy and other Coastal Plan guidelines; Coastal Plan studies conducted nationally and internationally; information on the study area; literature on data availability; and, literature on modelling methods. The publication findings were made publicly available on the Shire's website during the course of the project, and are still available on request.

In April 2015, the Shire hosted a Coastal Adaptation Information Forum in Port Denison. The forum brought together members of the community and representatives from the NACC, Curtin University, and DoP to discuss the project. Around twenty community members and other stakeholders attended the workshop and witnessed three presentations before taking part in a question and answer session and informal discussion. The community members included local landowners, fishermen, farmers, surfers and Tidy Towns volunteers. The workshop discussed topics such as coastal assets, hazards, processes, coastal data, planning, protection infrastructure, communication and partnerships.

The community members in attendance proved to be very knowledgeable about the coastline and coastal processes. The local knowledge they provided

FIGURE 10: Port Denison Inlet

was later incorporated into Curtin's Literature review, and included the following:

- The river mouth had been relocated by local people sometime during the early 1900's
- A trench dug in the early 80s on a sandbar, located between the river mouth and area known as nun's pool, disrupted normal coastal processes in the area;
- That there is limestone located immediately below the sandbar at the river mouth, which may explain why the sandbar builds-up regularly;
- The importance of the type of sand used for replenishing projects;
- The development of the port denison harbour has impacted significantly on coastal erosion along the areas known as granny's and surf beaches;
- That tidal impacts which have been seen upriver beyond the bridge as recently as march 2015.

Curtin's modelling methodology incorporated several steps including: field visits, a literature review, data collection and numerical modelling. It followed the methodology required by State Coastal Planning Policy 2.6 and was reviewed and considered satisfactory by the DoP and the Department of Transport (DoT), who are responsible for the coastline in Western Australia. Modelling was carried out for various inundation and erosion scenarios. This was the first time the Irwin coast has been modelled in this way.

While the accuracy of the modelling results was limited by the availability of accurate data, the results were reliable enough to be used as indicators and preliminary findings. Councillors and Shire staff then carried out risk analysis and evaluation of the inundation and erosion scenarios for each identified coastal hazard risk area. This resulted in a draft Coastal Plan, which included recommendations for various coastal adaptation actions. A community workshop was held, during which the draft plan was presented and discussed through a lengthy question and answer session. Following this, in 2016, the plan was advertised for public comment before being adopted by Council and sent to the DoP who were satisfied with the plan.

The purpose of the Shire's Coastal Plan is to provide strategic guidance on co-ordinated, integrated, and sustainable management, and the adaptation of land use and development plans in the coastal zone. It will assist both state government and the Council to accurately target resources, as the plan:

- Provides information on the effects of coastal hazards;
- Presents a decision-making framework to assess the associated risks;
- Highlights coastal hazard areas in terms of vulnerability and risk; and
- Suggests possible adaptation options.

According to the Coastal Plan, the most vulnerable part of the Shire's coastline is in the Port Denison area, just to the north of the harbour. This is something that the community was already aware of. In terms of adaptation, the plan recommends that more detailed studies should be carried out to investigate the need for coastal protection structures to protect/defend areas from erosion. This is something that the community was advocating, and it was something which they can participate in developing.

The plan also identifies the need to retrofit urban drainage systems in Port Denison to accommodate fluvial flooding. This action is consistent with the intent of the Green Infrastructure Strategy and will see the implementation of Water Sensitive Urban Design (WSUD) principles, such as planting trees and other vegetation in the road reserves and other public spaces. It is highly likely that the local Tidy Towns volunteers will actively participate in some of the adaptation projects.

FIGURE 11: Granny's Beach Port Denison

CONCLUSION

The Green Infrastructure Strategy is an innovative policy framework and action plan aimed at fulfilling the organisation's purpose and strategic direction. Developing this strategy has transformed the organisation's culture while signalling to the community that the Shire is developing environmentally, socially and economically sustainable infrastructure. We were pleased when the Western Australia Local Government Association added our Green Infrastructure strategy, which was produced in-house without the use of external funding or consultants, to their list of best practice climate change projects for other communities to follow.

As with all place-based strategies, there is a danger that the initial successes of the Green Infrastructure Strategy and the Coastal Plan will be forgotten and the community will become disillusioned and frustrated with the lack of action. According to a recent article on place-based rural development policies, the successful implementation of such strategies is heavily reliant on the local capacity for action and the leadership of local institutions, social ties and the quality of local resources.[8]

For the Shire of Irwin's place-based strategies to succeed the Shire, the TTSC, volunteers and partners must keep working to evolve the strategies and produce actions that have meaningful results. With this in mind, it is pleasing

FIGURE 12: Irwin River Revegetation

to know that in 2017/18 the TTSC volunteers partnered with the volunteers from the Dongara Town Centre Placemaking Group, and with the Shire's support, won a grant for a project to reduce the number of plastic bags by distributing jute bags. The grant also funded workshops and information sessions on recycling. Another success was the 2018 Shire Council's approval of a project to install solar energy panels on roofs of the Shire Administration Building and the Recreation Centre.

The technical complexities and significant financial costs of the adaptation recommendations proposed in the Coastal Plan mean that this plan may take longer to implement. Still, there are some positive synergies between both strategies, and with the community and their partners, which should see local people continuing to be involved in future actions.

According to the Intergovernmental Panel on Climate Change (IPCC), nations must manage their natural resources effectively and employ the use of renewable energy to ensure environmental sustainability and to mitigate the impacts of climate change.[9] In order to enable this to happen, local communities and local governments have the potential to play significant roles in improving environmental sustainability. The Shire of Irwin's Green Infrastructure Strategy is a place-based strategy that provides the community and their partners with an opportunity to mitigate the impacts of climate change.

The IPCC defines resilience as 'the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change'. The Shire's Coastal Plan has been developed with the assistance of a resourceful community, who are well-versed in the capacity for self-organisation and adaptability. The plan provides the community and their partners with opportunities to own and help implement adaptation actions that will build the local capacity to recover quickly from the coastal impacts of climate change.

By developing and implementing innovative place-based strategies involving people, place, partnerships, sustainability and resilience, the community and the Shire are leading by example in their support of the Australian Government's efforts to secure the desired outcomes of the Paris Agreement.

ENDNOTES

1 Australian Government, Department of Environment and Energy (2018) http://www.environment.gov.au/climate-change/government/international/paris-agreement

2 Tomaney, J. 2010, Place-Based Approaches to Regional Development: Global Trends and Australian Implications, Report for the Australian Business Foundation, Australian Business Foundation (2010).

3 Australian Government, Productivity Commission, Transitioning Regional Economies Productivity Commission Study Report (December 2017).

4 The benefits of this positive organisational culture were displayed in 2014, when a cross-functional team of Shire officers won the Western Australian Local Government Managers Association Management Challenge in 2014, before going on to represent the state in the national final. This management competition challenges participating councils to develop innovative responses to complex public sector problems within the context of a fast changing local government environment. Though lacking a full set of professional services, the Shire's positive and innovative culture meant it was well-placed to compete successfully against larger, better resourced local governments.

5 The Tidy Towns Sustainable Committee is a Council Committee comprised of Councillors and local volunteers. The Committee is responsible for driving local environmental management initiatives.

6 The Northern Agricultural Catchments Council is one of Australia's 56 regional natural resource management organisations. The organisation is funded by the state government and supports the natural environment in Western Australia's Northern Agricultural Region.

7 The first German community to become completely energy self-sufficient.

8 Rosanna Salvia and Giovanni Quaranta, Place-Based Rural Development and Resilience: A Lesson from a Small Community, Department of Mathematics, Computer Science and Economics, University of Basilicata (May 2017).

9 M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (eds), International Panel on Climate Change, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA (2007).

THE RESILIENCE OF INFORMAL SETTLEMENTS
ADDRESSING QUALITY IN THE BUILT ENVIRONMENT

RAKHI MEHRA, MARCO FERRARIO, AMARINDER ARORA

FIGURE 1: An informal settlement in the North-West of Delhi

The urban poor, those most affected by the consequences of climate change, often find affordable shelter in non-engineered housing with a low resilience to natural hazards.

To address the scale of the problem, it is imperative to highlight the key role that informal settlements play in the urbanization process. Once this is acknowledged, it is for all stakeholders to study the challenges and to effectively catalyze and influence the spontaneous development of informal neighborhoods. Different agencies can act to improve the overall quality of the built environment. Today's widespread diffusion of technology gives us the opportunity to align the diverse interests of lenders, government, NGOs, skill development organizations to empower communities engaged in the practice of incremental housing.

BACKGROUND

Of the world's 7.4 billion people, approximately 4 billion live in urban areas according to the 2016 UN Habitat World Cities Report. Of the total urban population, about 1 billion people are living in informal settlements[1] . Presently, 58% of South and Central Asia's population are living in informal areas (UN-HABITAT 2011).

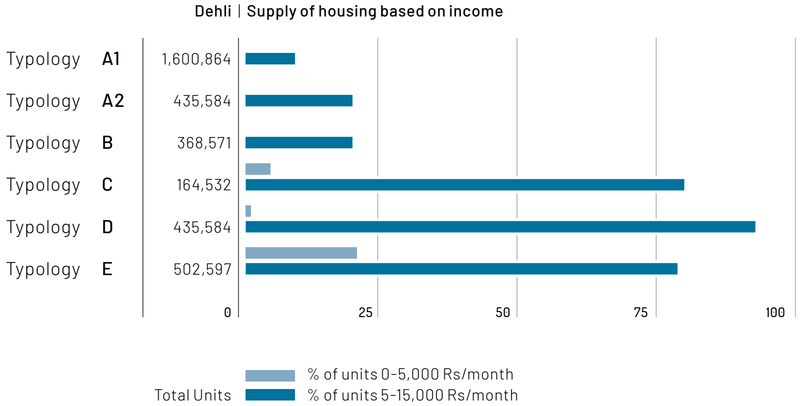
As in most developing countries, India's urban areas make a major contribution to the country's economy. Indian cities contribute about two thirds of the economic output, host a growing share of the population, are the main recipients of Foreign Direct Investment (FDI), and are the originators of innovation and

FIGURE 2: The informal settlement of Dharavi in Mumbai. It offers affordable housing to millions of people in the hearth of Mumbai

technology. Over the next two decades India's urban population is projected an increase from 282 million to 590 million people. Like other countries of South Asia, towns and cities in India have expanded rapidly as an increasing number of people migrate from rural areas to towns and cities in search of opportunity. Within this accelerating urban growth, spontaneous settlements commonly called "informal settlements", and in some cases "slums", are the fastest growing land use component. Since the latter part of the 20th century, the accelerated rise of such areas poses serious concerns both for the residents living in informal settlements who do not have the basic requirements for a decent life, as well as for the wider implications of the overall quality of life for cities, their countries and indeed the world.

While the main problems of such neighborhoods are access to basic infrastructures and services, the housing in informal settlements is often poorly built, making informal communities extremely low-resilient to natural hazards such as floods or earthquakes.

This article investigates the sustainability and resilience of the informal urban built in India. We base our observations on the practical experience and research conducted by the authors and the mHS CITY LAB[2]. We offer insights about this housing problem as well as a series of interventions to improve the resilience of informal settlements in the face of climate change and natural hazards.



SUPPLY OF affordable housing based on income per typology in Delhi; 2011 Data

INFORMAL SETTLEMENTS – THE SPONTANEOUS CITY

Most informal settlements result from the gap between the demand and supply of affordable housing.

The current adequate housing deficit in India stands at 19 million units, which, in the absence of any meaningful intervention, is slated to double to 38 million units by 2030.

Ninety five percent of these houses (a staggering 18 million units) provide shelter to people in the Economically Weaker Section[3] (EWS) and a great segment of the Low-Income Group[4] (LIG). Some other units house people in the lower to middle end of Middle Income Group. This later group comprises 'the emerging middle class', who are also deprived of decent living conditions. (Affordable Housing in India, JLL).

FIGURES 3 and 4: Two settlements of Type F. The risk of eviction is high and as a consequence the investment done by their household is minimum. It is evident the temporaneity of the structures limited to one floor high

The 2011 Census of India reported that a total of 65.49 million people (13.9 million households) live in informal settlements located in 2613 cities/towns spread across 31 States and Union Territories. This enumerated informal population constitutes 5.4 per cent of the total population of the country and 17.4 percent of the total urban population of all the States and Union Territories (2011). These organic and sporadic settlements built incrementally, provide affordable housing and rentals to millions but suffer from lack of basic amenities, overcrowding and poor quality of spaces (Davis, 2006).

THE ROLE OF TENURE AND ZONING IN INFORMAL SETTLEMENTS

The nomenclature in government records identifies informal settlements in different categories such as slums, shanties or JJ Clusters[5]. In Delhi alone, there are seven different categories to describe non-formal settlements.

We present a simplified classification which highlights the relationship between the type of settlement and the condition of its housing. This typology grouping (developed for the World Bank[6]) focuses on 3 criteria: 1.) the legality of ownership; 2.) the capacity to trade the property; and, 3.) the zoning which defines that tenancy[7]. The main premise is based on the property rights which influence the dwellers' perceived right to make decisions regarding construction, expansion or improvements, as detailed in the next section. The proposed classification leads to 7 different typologies, ranging from locations that have a decent level of property rights and appropriate land use, to informal locations where no rights have been accorded, and land use is non-residential. The following is the brief description of the typologies.

FIGURE 5: An Urban Village in New Delhi. Belonging to the Type B, the relative security of the property rights justify the construction of permanent structures of multiple levels

	Title/ Ownership	Tenancy	Right to Sell	Correct Zoning
Type A1	✓	✓	✓	✓
Type A2*	✓	✓	✓	✓
Type B	✓	✓	Informal	✓
Type C	✓	Partial	Informal	No
Type D	Limited	✓	Informal	✓
Type E	None	Limited	Informal	Either
Type F	None	None	Informal	No

* In settlements of Type A2 the property rights are the result of regularizations

TABLE 1: mHS proposed settlements classifications. The proposed classification leads to 7 different typologies ranging from locations that have a decent level of property rights and appropriate land use, to informal locations where no rights have been accorded, and land use is non-residential. Various settlements and the existing local typologies of various cities in India have been studies and mapped back to the above-mentioned classification

Type A1. Settlements characterized by registered title, right to tenancy and appropriate zoning. Households in these communities have free/ leasehold title on their land and are registered in the government administrative system/listing. They have the right to transfer/sell their property. This category usually refers to planned colonies and settlements in the urban area.

Type A2. Households in A2 settlements have clear titles and full tenancy after a process of land regularization process. This gives settlements the same status as A1 communities. Usually residents in this category belong to a lower income segment and plot sizes are smaller.

Type B. Households in this group have titles (but may not be registered in the formal revenue records) and full tenancy. Often, they can trade the property through an informal system.

Type C. Households in these locations have proof of land ownership/Power of Attorney. They have bought the land after an informal division of the land (usually not falling under residential zone as per the master-plan or other statutory document governing the land-use of a city) into small plots. Unauthorized colonies built on historically agricultural land are an example.

Type D. These locations share a lease/ license document, varying from 5 to 99 years, usually given by the government, but with the restriction of selling. Despite the restrictions it is common practice to trade through Power of Attorney documents. In Delhi, *Resettlement Colonies* are part of this Type.

Type E. Households in these locations have no right or ownership for their land. As for tenancy, they merely possess the right to occupy, in some cases an authority intervention could give dwellers a ‘no eviction’ guarantee. These settlements may, or may not, fall under residential land, but almost always are on encroached land.

Type F. Settlements where the households have no ownership or tenancy right and live in non-residential zones. This is because the land is in encroached pockets in protected, public or private land. Especially when on protected or green land, these settlements are usually prone to relocation/ eviction.

Sl. No.	Typology	City based housing category	Percentage of population residing	Population	Considered Examples
1	A1	Planned Colonies	23,7	4 020 776	Greater Kailash -1, Outrun Lines
2	A1	Slum Designated Areas	19,1	3 183 115	Old Delhi
3	A2	Regularized Unauthorized Colonies	12,7	2 177 921	Lakshmi Nagar, Karkar Duma
4	B	Rural Villages	5,3	837 662	Savda Village, Mandi Village
5	B	Urban Villages	6,4	1 005 194	Khirki Village, Khizrabad Village
6	C	Unauthorized Colonies	5,3	837 662	Sanjay Colony, Sangam Vihar
7	D	Resettlement Colonies	12,7	2 177 921	Savda Ghevda, Mangolpuri
8	E	JJ Clusters	14,8	2 512 985	Sunder Nagri, Kalkaji Camp

TABLE 2: Arrangement of the various settlement of Delhi based on the proposed classification

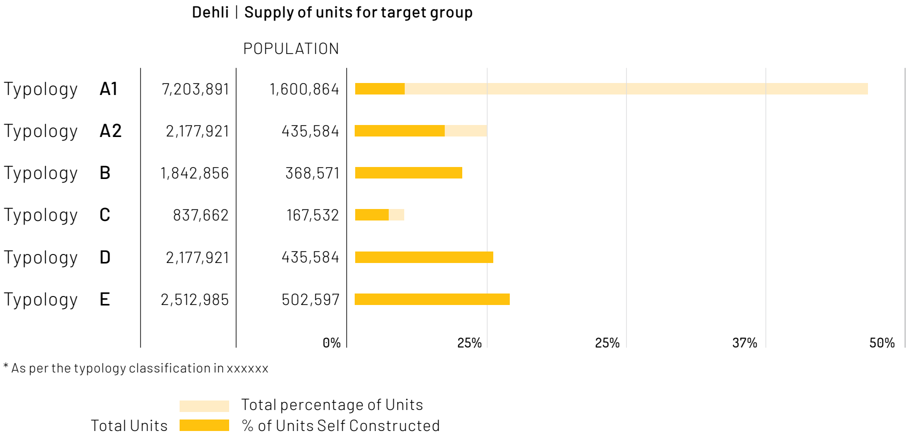
THE PRACTICE OF SELF-CONSTRUCTION

A key aspect of informal settlements is the practice of self-construction (also referred to as “incremental housing”, “self-build” and “home improvement”). It is the process in which the homeowner is closely involved in every aspect of building, extending, or refurbishing her/his unit by undertaking the building work himself/herself or by contracting a mason under close supervision. It is a commonly held belief by low-income families that the land that they live on is their major source of wealth or security, despite varying tenure conditions. Self-construction enhances their sense of financial security. This practice is not usually guided by safety design standards or building norms and it is influenced by word-of-mouth and informal knowledge of construction practices and technology (mHS, 2011).

There is positive relationship between the size of the urban centers and the quality of self-constructed buildings and between the various typologies of settlements and the quality of the units. There also are technical differences across tiers of city size. Smaller cities often offer the opportunity to expand horizontally,

FIGURE 6: Savda Ghevra: a resettlement colony belonging to Type D in North-west Delhi. The limited tenure (5 years) granted by the Government is not sufficient to stop the development. Multistory structures are bursting rapidly densifying the settlements. These structures have an extremely low resilience to earthquakes

while in larger cities the lack of land spurs households to build vertically[8]. Where land is more available, better living standards can be found allowing for ventilation and lights options.



GRAPH 2: Incidence of self-construction per typology in Delhi; 2011 Data

The phenomenon and practice of self-construction is present cross all typologies (aside that of Type A). Within an urban center, there is a parallel between the quality of the built environment and the typology considered. Lower Typologies (Type D and F) where the risk of eviction is a constant, lead to temporary structures that usually stand one floor high. Households typically do not invest to build multi-story housing. Given the lighter structure and limited floors in single story buildings, the risk in these locations is more linked to events such as fires or floods, rather than earthquakes.

FIGURE 7: Mongolpuri - A Type D resettlement Colony in north Delhi. The majority of 7x3 meters units are already multi-story, built incrementally over the last decades

In typology D and C, buildings are usually multi-story and the number of floors varies based on their age or level of tenancy. In Delhi these locations are up to 4 floors (ground level and 3 stories) demonstrating poor quality of construction.

Type B are often settlements that have been encompassed in the city because of sprawl. Here construction is again permanent, and the number of floors can even exceed that of the Master Plan that regulates the formal part of the city (this is the case of Urban Villages in Delhi). While the number of floors can reach 5 or 6 stories, the cost of real estate is usually higher than the above typologies (apart Type A) given the status, the size and cost of the units. It quite common that the homeowners rely on contractors that have access to some technical capacity to build the units. As a result, quality can vary but it usually better than that of Type D and C.

Type A2 are settlements that have engaged in a process of regularization or formalization of property rights after tenancy. The built structures are permanent in nature and these locations can experience a drastic expansion when the authorization is given, and the risk related to eviction decreases.

FIGURE 8: Self- construction is incremental in its nature as it follows the financial capacity of low-income dwellers and the possible variation of property rights

THE RESILENCE OF INFORMAL SETTLEMENTS
THE CHALLENGES IN SELF-CONSTRUCTION

Informal dwellers face a multitude of challenges during the construction process. The local mason or contractor is typically the cornerstone of the construction process. This craftsman plays the role of architect, builder, engineer, contractor, and in some cases, materials supplier. Yet he typically has little to no formal training.

As a result, without access to professional technical assistance, sometimes discrepancies in budget estimates happen resulting in short-cuts to construction, and, more critically, the builders' lack of training leads to unsound structures which put families in danger in case of natural disasters. In some cases, poor construction requires households to spend greater resources on maintenance. An extract from 2017 European Microfinance Award catalogue highlights the impact of the quality and safety of the houses on their dwellers.

"... housing is not a vertical 'silo'; rather it is closely intertwined with – and often the cause of – a whole host of developmental problems. Exposure to the elements, poor ventilation, and insufficient arrangements for basic hygiene are major causes of poor health. Improper building structures undermine safety and vastly increase vulnerability to disaster. Lack of lighting and sufficient space limits children's ability to study. Insufficient privacy and lack of toilet facilities contribute to sexual assault and constraints opportunities for women and girls."

FIGURE 9: Self-construction can unfortunately lead to structures extremely vulnerable, like this one. Key inputs on the structures and awareness about the risks can correct this situation

MEASURING THE RISK

Earthquakes[9] are natural hazards, but the disasters are man-made. According to the National Disaster Management Division, Ministry of Home Affairs, Government of India, "Earthquakes don't kill, unsafe buildings do. It is the high vulnerability of our building stock that turns these hazards into disasters". Faulty designs, weak construction materials and poor maintenance, non-compliance to seismic safety regulations lead to extensive collapses of engineered and non-engineered buildings during earthquakes. The failure of these buildings is the main contributor to the loss of lifes and injuries to the people along with the economic damages.

India is a diverse country with a varied landscape, terrain and climates. Most parts of the country have high seismic risk. In 2002 the Government of India did a categorization of geographic areas into five seismic zones, Zone- I, II, III, IV, & V (wherein Zone-V have the highest seismic risk). It is important to note that the entire country shares a seismic risk.

Figure 10 compares the seismic map with the density map of India, clearly showing there is a concentration of habitation and population along the seismic sensitive zones. This implies the urgent need to address safety in construction providing technical assistance.

A study undertaken by mHS in 2011 attempts to highlight the high seismic risk present in two diverse urban informal settlements in Delhi (Mongolpuri and Savda Ghevra), located in Northern India. The technical team at mHS examined 50 building in the resettlement colony of Mongolpuri (Delhi) and found that almost 70% of the units had a level of structural safety over 5 times less than the minimum expected for that geographic area and the related peak ground acceleration.

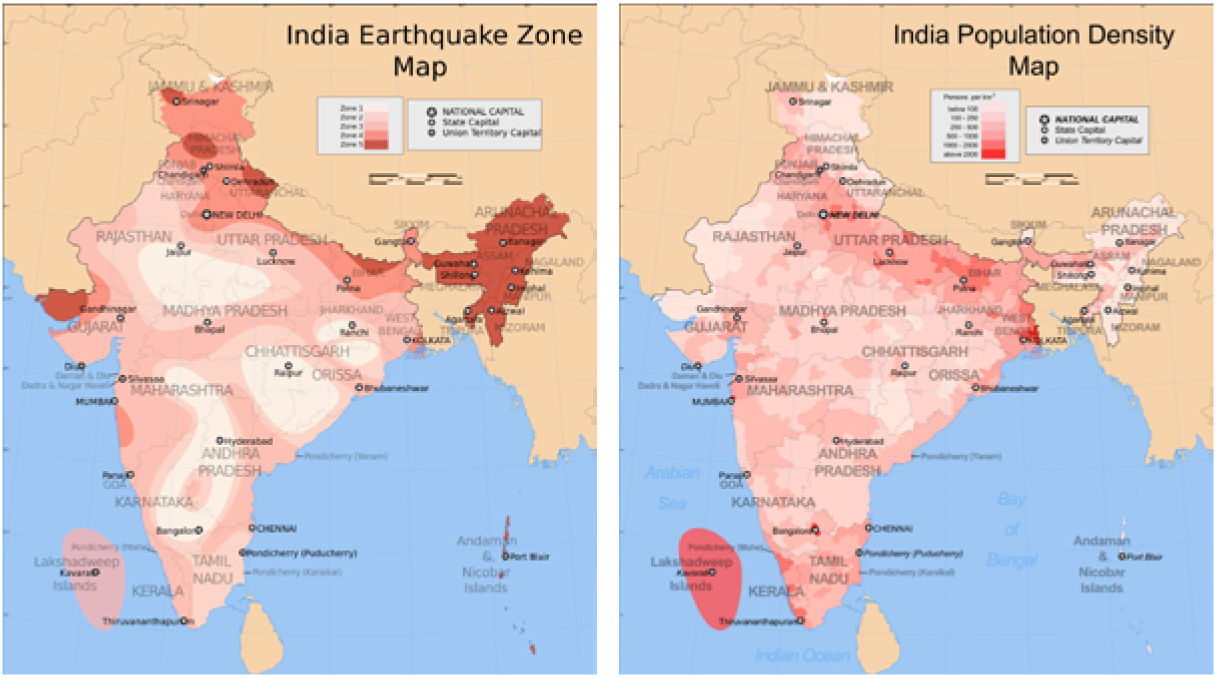


FIGURE 10: The seismic map with the density map of India. Source: Wikipedia

Based on the experience across India, we have learned that errors undertaken during self-construction are not always driven by lack of resources or the need to save money. Rather it is a lack of knowledge and the presence of gross mistakes that reduce the quality and safety of the units. Our theory it is that by creating awareness, imparting basic knowledge and customized inputs, wrong practices can be corrected, drastically improving the strength of the structures.

LEARNING AND THE WAY FORWARD

The self-construction context presents an opportunity for the various stakeholders to influence housing quality by enabling safer construction practices. There are several possible conceptual methods to address the self-construction market. While the Government should play a key role, working with the other stakeholders present in the community, it is very important to understand the socio and economic networks of the informal settlements.

The key actors of the self-construction practice are the masons and material suppliers. Working with masons exposing them to technical knowledge for safe construction and spreading awareness about good construction practices is a legitimate way to improve constructed safety. Material suppliers could also play a key role by divulgating safe construction practices and providing financial and technical support to mason's program.

Another key stakeholder group is financial institutions offering housing loans. Financial institutions are currently involved in the housing finance landscape in three ways: direct lending to consumers, indirect lending to State Housing Boards or housing finance institutions, or investments in mortgage backed securities, which is currently in its incipient stages in India.

The Government of India through its National Disaster Management Authority (NDMA), has published a set of guidelines (NDMA, 2010) requiring lending institutions to take responsibility regarding the quality and safety of the construction of buildings financed directly by them. The policy states that... *"the onus of checking the compliance to safety provisions by the loan-financed buildings lies with the banks extending housing loans".* The guidelines recognize the partial failure of the Techno-Legal Regime "resulting in avoidable damage to the built environment and the consequent adverse economic impact (NDMA, 2010).

In principle, lending for home upgrades and self-construction is an opportunity to bring technical assistance in a structured manner as part of a financeable, viable product. The main strategy in this is to create a mechanism that would make the low-income segment attractive to building professionals, mostly through aggregation of clients. In parallel, creating awareness on the risks and problems of self-construction and bringing knowledge to the people such as masons/contracts through training camps would be the strategy on the demand side. The final scope is to ensure that financial companies will take over the responsibility to ensure that the houses they finance will be built following safety and quality standards.

Lastly, the Government of India recently launched the 'Housing for All by 2022' scheme under the Pradham Mantri Awas Yojana scheme (PMAY). While the thrust is on rebuilding and mass scale housing projects, there is also a section on Beneficiary Led Construction (BLC) to provide housing subsidies for incremental housing construction. Offering effective construction technical assistance for each house subsidized and monitoring the quality during construction, could ensure quality and safer houses.

DHS - A PILOT FINANCING-BASED PRODUCT

Based on the findings from a pilot project in Delhi, mHS suggests that improvements in the incremental housing construction processes can be achieved by providing: a.) access to construction inputs, customized for each project easy to be understood; and, b.) upgrading information and skills of the contractor and mason.

DHS CONCEPT

In 2010, mHS CITY LAB conceptualized a product-named DHS, to bring construction finance and technical assistance to informal households supported by Michael and Susan Dell Foundation. The technical assistance comprised customized architectural and engineering solutions, including pre-construction advice and monitoring during edification. The housing loan for the pilot was provided by the partnership with BASIX-BSFL a micro-finance institution. The need for finance was intended to drive customers participation into the program and the technical assistance was provided as a mandatory service that would monitor construction process and control the release of loan amounts.
The objective of the pilot was to identify a path to scale and learn about the nature of the market, especially the customer's receptivity and preferences. The DHS concept was tested on a pilot project in Mongolpuri, Delhi after a 1500 households survey in three different settlements. While the interdisciplinary team at mHS had expertise in project design, community engagement, architecture and urban design, there were the need for the financial part of the product and the community reach. BSFL, one of the eight different entities of BASIX and partnership with a local NGO, Dr AV Baliga Trust, facilitated a process to bring community awareness about the product and bring the opportunity to their customer base.

Other stakeholders that were involved in the self-construction process were reached. These stakeholders include the community leader or ***pradhan***, the government agencies, material suppliers, masons and contractors.

The DHS pilot was conceptualized and implemented in four different stages; 1. customer acquisition; 2. pre-construction; 3. Construction; and, 4. post-construction.

In the client acquisition stage, the BASIX team scouted the neighborhood of Mongolpuri for families (especially those already reached by the Baliga Trust community workers) with a desire to upgrade their homes. The team explained the product to the clients including the technical assistance component, and conducted an internal assessment of the client's creditworthiness, critical to the long-term impact of the project. If the client passed the internal review, the mHS architectural team conducted an initial client visit to assess the technical feasibility of the case and provide cost estimates to the MFI. If the client passed both the technical and financial audits, and they agreed to the terms of the product, they became a DHS client. Out of the 600 clients approached by BASIX, about 40 were selected to participate in the project. While many clients used the funds to implement small repair and expansions, 12 families agreed to rebuild their houses rather than adding additional floors.

The mHS team worked closely with the client to draft the architectural plans that were both structurally sound and that met the needs of the family. Simultaneously, BASIX sanctioned the loan, ready for disbursal once the construction began.

The clients funded an initial investment of 20% as a sign of commitment before the first disbursal by BASIX, subsequently leading to the construction of foundation. The construction phase was the most intensive phase for the mHS team; there was the need to be on site every other day for 3 months to monitor construction and ensure the structural soundness of the building.

The DHS pilot was designed to provide feedback to both mHS and BASIX about the value-proposition of such a product, including the pricing, marketing, communication strategy and incorporating feedback from the day-to-day operational challenges. If successful, the pilot would also assist in developing a market entry and pan-India rollout strategy for the product.

While the credit was based on business models already tested by the lender, the product had a technical fee charged from the client, which along with a partnership ship fee from the MFI was supposed to cover all costs of providing technical assistance at scale.

The pilot validated the proof of concept on the value proposition of providing technical assistance. However, the cost of being in the field well exceeded the small technical fee charged to the clients and it was clear that even a scale, the business model was to be reviewed.

mHS team began to reconsider the delivery model of TA by leveraging technology and mobile connected platforms.

BEFORE AFTER

FIGURE 11: Shoba has been one of the first client of the DHS Pilot. Here her house before the intervention and after the DHS project

While there is a role for trade, finance and government to improve the safety of informal structures, mHS' on-ground experience working with experienced players like BASIX and Mahila Housing SEWA Trust suggests that improvements to the self-construction process can only be tapped through a collaborative and participative approach. Community engagement is at the core of the model to draw in the target income group, which has been denied the right to decent living conditions and be a part of the development process, thus becoming resistant to change. These communities often do not prioritize safety or understand the extent of structural failure present in non-engineered housing.

The cost needed to hire construction professionals is prohibitive along with the deliver cost of providing door-to-door construction assistance and monitoring, a key insight that was learned during the DHS pilot. Another related challenge is the difficulty to hire and attract qualified construction professionals, such as engineers willing to join this market. This problem was as well explained by a young engineer we interviewed; "Why should I join a bank to monitor small units projects when I can work in a proper office on bigger buildings?"

In countries such as Indonesia and Brazil, that have a better articulated policy on incremental housing, the provision of technical assistance services is often sponsored by the National Programs. However, these call for large budgetary resources and raise questions about the sustainability of the Programs.

BRIDGING THE GAP WITH CONSTRUCTION PROFESSIONALS THE ROLE OF TECHNOLOGY

It is thus critical to bridge the huge gap that exists between the low-income communities, or rather the stakeholders holding them as customers, and of how architectural and engineering services are delivered. This requires rethinking the typical role of the commissioned designer.

Technology could offer a huge potential by providing design and engineering expertise to low-income communities through applications on mobile platforms, which having become an essential device in most households, are becoming increasingly affordable. This requires a collective intelligence between the artificial intelligence of digital technology combined by the algorithms created through technical expertise. (Mehra, Ferrario, Janu, 2017)

At mHS, it is envisioned that leveraging the proliferation of the digital medium – in the form of a construction toolkit on a digital platform, can overcome the complexities of informal settlements. With the scale and spread of digital tools, the vision is to offer algorithms for construction design and planning through intuitive user interfaces that can self-learn and evolve based on user inputs and experiences over time.

With the objective to develop and offer a set of customized and practical digital solutions to-that can be replicated and implemented in different geographies, the authors seek to empower the users of the tools, both institutional and end-users, to improve the quality of building in the incremental context.

THE WAY FORWARD – INNOVATION IN DELIVERING CTA

Based on the learning from DHS, mHS developed a digital solution named rclCloud.
The software is based on algorithms developed on two key components:

1. An engineering solution designed with special consideration for earthquake zones and construction types, and
2. A design assumption specifically studied for the characteristics of the buildings in informal settlements.

This repository of technical solutions allows the system to create customized project data from a set of project inputs.
The project data can be used to generate accurate cost-estimates to assist clients and lenders with project budgeting and loan sanctioning.
By collecting other simple inputs on the stage of construction, the system uses the same set of data to generate an estimate of the cost of construction at that stage for quicker and more efficient loans disbursal according.
More critically rclCloud can generate project manuals with the specific structural design of the considered project. Information on specific elements of the building (i.e. foundation dimensions, columns and beams numbers, size and reinforcement, etc.) are provided in the form of simple graphics easy to understand to guide customers during construction and the same can be used to check quality of construction.

CONCLUSION

Informal houses provide shelter to a billion people world-wide. Unfortunately, much of this housing is of low quality and is in hazardous location which leads to structural failures, loss of life and property damage. The problem of low resilience to natural and climate related events can be addressed by mobilizing various stakeholders in the housing industry to encourage better construction practices and by making critical construction information easy to access using application on mobile phone.

ENDNOTES

1 Slums, Informal Settlements and Inclusive Growth in Cities, Judith A. Hermanson, IHC Global

2 http://www.mhscitylab.org/

3 See: http://www.arthapedia.in/index.php?title=Economically_Weaker_Sections_(EWS

4 See: https://www.quora.com/What-are-the-lower-income-group-categories-in-India

5 Categorization of Settlements in Delhi, Center for Policy Research, 2015. http://www.cprindia.org/sites/default/files/policy-briefs/Categorisation-of-Settlement-in-Delhi.pdf

6 mHS developed this typology classification while serving as a consultant for the World Bank to support the project: *Low Income Housing Finance Project for India*. See: http://projects.worldbank.org/P119039/india-financing-affordable-housing?lang=en

7 There are other studies that suggested other classifications of informal settlements (Kundu 2004; Dutta, Chander et al. 2005) including criteria based on density, income to name a few.

8 Another issue is the proliferation of structures built with Reinforced Concrete frame structures in the past 50 years. This construction method has led to a high number of non-engineered buildings, which when multi-story, demonstrate a lower level of safety. As the number of floors increase, the safety factor decreases. As a result, self-construction in megacities is generally of poorer quality.

9 There may be a link between earthquakes and climate change. See: https://www.sciencenews.org/article/book-review-waking-giant-how-changing-climate-triggers-earthquakes-tsunamis-and-volcanoes

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CLIMATE CHANGE PLANNING TOOLS

TOWARDS CLIMATE RESILIENT PLANNING IN VIENNA
FROM MODELS TO CLIMATE SERVICES

TANJA TÖTZER, WOLFGANG LOIBL,
NIKOLAS NEUBERT, JÜRGEN PREISS

FIGURE 1: View to Vienna´s most modern urban district, the "Donaucity", close to large recreational areas such as the Danube island and Danube park

RESPONSIVE CITIES

The idea of climate adapted urban planning and design is as old as our cities themselves. The physical pattern of cities frequently reflects, to some degree, their local climate conditions – e.g. narrow, shadowed streets and compact buildings can be found in regions with hot summers and cold winters whereas open designs for optimal air ventilation are typical for damp-warm climate zones. However today, the intersection of rapid urban growth of the last decades and the unprecedented rapidly changing climate conditions, such as increased episodes of heavy rains or longer and hotter heat waves, require that new design solutions have to be added to traditional urban development planning practices. We cannot ignore these new climate and rapid growth events as they increase mortality, cause other public health issues, and can cause large scale economic damage to properties and global value chains. City administrations need to offer their citizens solutions that increase liveability, secure habitats, and provide the assurance of a reliable base for the operation for businesses. Municipalities and their associated public operators also need to secure their investments in public infrastructures, fleets etc.

The city of Vienna, which is famous for its high quality of life and its very comprehensive smart city approach, has become a leader in recognizing the need for, and establishing itself into, a climate resilience urban development. The Austrian Institute of Technology (AIT) has been assisting the city of Vienna and its development process towards climate resilient planning for over a decade. This paper describes this collaboration, which marks a further effort to make Vienna more sustainable.

FIGURE 2: Climate related hazards are getting an urban reality. Flood water in the inner-city of Vienna

WHY CLIMATE RESILIENT PLANNING?

In 2018 Mercer ranked Vienna as the city with the highest worldwide quality of living – this for the 9th year in a row ![1] One of the categories analysed for the Mercer study deals with the natural environment and includes climate aspects and recreation facilities, such as parks and huge green areas.[2]

As a highly attractive place to live and do business, the City of Vienna with its 1.87 million inhabitants (2017) is steadily growing.[3] During the last five years (2013-2017) the Viennese population increased on average by around 30,000 inhabitants each year, creating the annual need for about 10,000 new apartments. This on-going population growth required both the planning of new districts as well as the establishment of new growth policies. However, the policies and plans, which enabled densification, became highly topical.

Beside densification in new settlement areas, the need emerged to get a clear understanding of the current and future microclimatic situation in built areas of the city, especially those with existing compact middle-European urban structures, where green spaces were allocated for representation purposes and a large share of the building stock dates to the 17th to 19th century.

Another issue resulted from an analysis of the city's land use. It found that about half of the Viennese city area can be considered green; meaning that it consists of large green areas such as parks, agricultural lands and urban forests. However, the green areas are not evenly distributed. The green share within the municipal districts varies from 2% to 15% in the inner city and up to 70% in the western districts, due to their hilly topography and forested areas.[4]

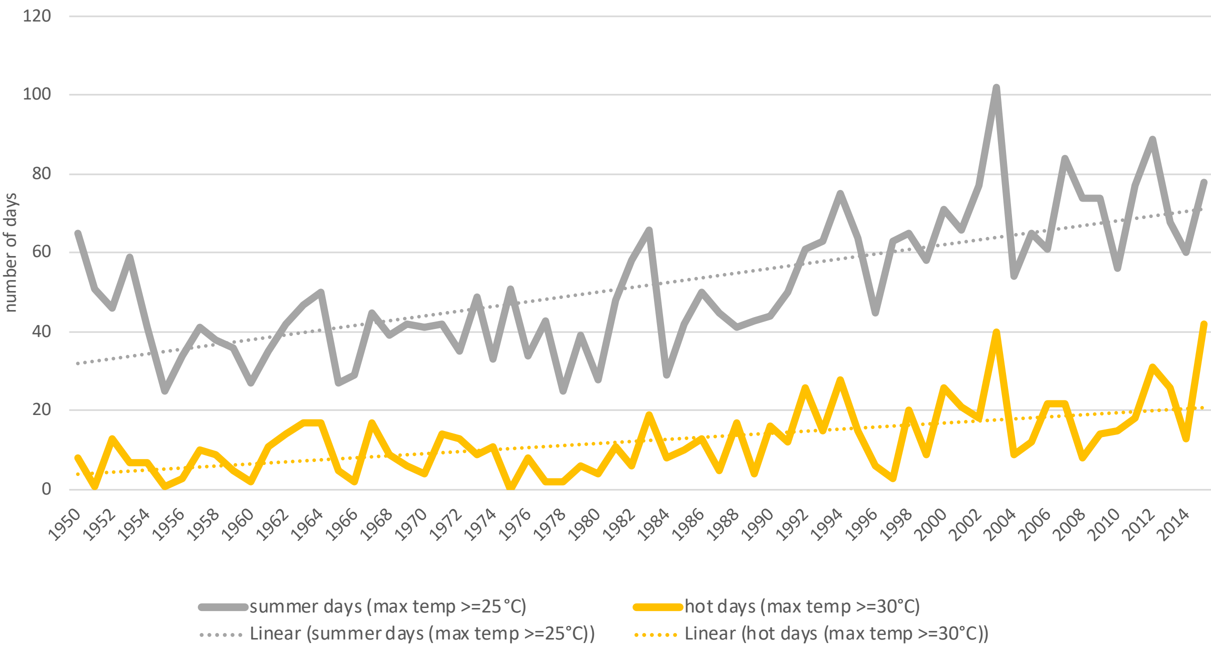
Finally, there was the need to get a clear understanding of the climate performance of the city, which is located in a transition climate zone influenced by oceanic and continental climates. This results in low precipitation totals and longer dry periods during summer and autumn. Particularly in summer, Vienna faces rising temperatures and peak periods of extreme heat. Climate change is already evident. For example, in 2016 Vienna experienced the fourth-warmest year since 1775 when regular temperature records where documented.[5] During the greatest heat period in Austria, in August 2017, the city centre of Vienna observed a daily maximum of up to 38.9°C.[6] Meteorological records since 1950 show a trend towards an increase of summer days (max. > 25°C), hot days (max. > 30°C) and tropical nights (min. > 20°C).[7]

These circumstances, of ongoing urban growth, unevenly distributed green, compact urban shape coupled with a warming and drier climate trend produced the need for Vienna to pioneer climate resilient planning if it was to maintain its high quality of life.

FIGURE 3: One of Vienna´s largest development areas "In der Wiesen" transforming open, agriculturally used areas into residential areas

FIGURE 4: ↑ How to design transformation towards resilience in a compact city like Vienna?

FIGURE 5: ↓ Increasing number of summer days and hot days in Vienna from 1950 to 2013.
SOURCE: ZAMG, own illustration



CLIMATE MODELLING FOR ASSESSING THE IMPACTS ON URBAN CLIMATE

For more than 15 years AIT has been engaged in conducting regional climate simulation modelling of current and future climate conditions. Our first projects focussed on the testing of regional climate and microclimate models and the modelling of current and future climatic patterns. This work helped the city to achieve a better understanding of microclimatic conditions in particular urban structures and of the future effects climate change may have on on the city as a whole.

One big challenge in climate modelling is the numerical downscaling of global scale climate simulations from the General Circulation Models (GCMs) to a regional and urban scale. In the project “reclip.century”, AIT and three partner institutions, carried out 21st century climate simulations for the Greater Alpine Region providing hourly data for 10x10 km grids, which have been further downscaled in Austria to 4x4 km grids. Currently AIT is conducting transient urban climate scenarios with 1x1 km grids for the Greater Vienna Region, applying a model version tailored for urban climate simulation involving additional high-resolution data sets. Climate scenarios on an hourly base for a century with 1x1 km resolution can be seen as a milestone for urban climate modelling.

After developing a holistic understanding of the urban climate, the next step was to link our models to on-going urban planning processes. This transition was first realized with the planning of the new “aspern Seestadt” (aspern lakeside), designed to accommodate more than 20,000 inhabitants[8]. The City’s goal was to establish a smart and sustainable show case development. In terms of climate, this meant that the urban design master plan had to be climate proofed to provide a sustainable planning framework for the ongoing development of the new urban district.

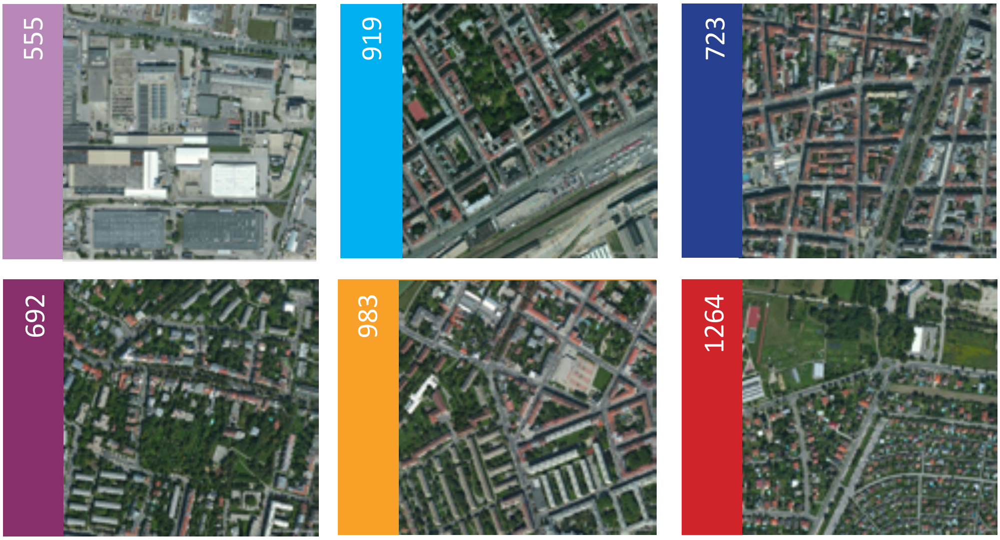
Several research projects supported this planning process. In the aspern Seestadt climate project (“Open space and Microclimate: Foundations for climate sensitive urban planning in Aspern”), the microclimate simulation was conducted for the entire area to provide microclimate indicators for specific block layouts. Based on this, planning and design guidelines for climate sensitive urban planning were established to improve the design of the new district with respect to block layout, surface properties and green open space share. The projects carried out for aspern Seestadt showed that the original master plan provided a good baseline for climate sensitive planning. Only a few adjustments were necessary and these have been implemented with respect to the orientation of streets, building height distribution and open space design addressing surface layout and vegetation distribution. This made aspern Seestadt a kind of prototype for integrated climate resilient planning in Vienna.[9]

FIGURE 6A+6B: Aspern Seestadt is Vienna´s most known and one of Europe's largest urban development projects. With a lake in the middle, extensive green areas and excellent transport links it is designed to become a show case for a new climate resilient urban district of Vienna

URBAN FABRIC
TYPE 1, 23RD DISTRICT
“urban fringe, industry and urban expansion zone“

URBAN FABRIC
TYPE 2B – 4TH DISTRICT
“inner city: perimeter block structure, late 19th century, close to city center, in slope position”

URBAN FABRIC TYPE
2A – 8/9/16/17TH DISTRICT
“inner city: perimeter block structure, late 19th century, close to city center”



URBAN FABRIC
TYPE 4 –19TH DISTRICT
“suburban area, in slope position”

URBAN FABRIC
TYPE 3B – 21ST DISTRICT
“suburban area, Vienna Basin”

URBAN FABRIC
TYPE 3A – 21ST DISTRICT
“sparsely populated Vienna Basin – mixed structure”

FIGURE 7: Microclimate modelling helps to show the effects of certain design and greening measures. It illustrates that planting tree rows along the south-eastern facades massively improves the microclimatic situation of the street blocks behind

After setting a case for large-scale urban planning and property development, the next challenge was to investigate impact-oriented generic design recommendations which could be applied to existing urban structures. AIT, partnered with national and international partners from Technical University of Vienna and the Technical University of Munich, conducted microclimate modelling for potentially exposed urban fabric types (for more details see [10]). In this project the triggers of local urban heat island effects were explored.

We also examined how open space characteristics, interacted with different surface properties and densities, could lead to negative impacts in urban environments. To achieve this, we modelled the effects of various climate design measures on different open space types located in the most exposed urban areas. Based on the model outcomes, green open space strategies were developed to mitigate negative effects at the local level. This equipped the city with general recommendations for UHI-reducing measures as well as with urban fabric type specific recommendations for guiding tailor-made design measures to counter climate stresses in different urban structures of Vienna.

The climate related projects carried out in cooperation with the city provided a valuable basis to understand how urban form affects urban climate and to understand how counter measures can be set. These advancements towards climate resilient planning increasingly raised our awareness and enabled us to think about acting on a more strategic scale.

FIGURE 8: Green facades to shade and humify the rooms behind instead of air-conditioning on a MA 48 - Waste Management Department building. SOURCE: MA 22

BOX 1: CLIMATE RESILIENCE

IPCC[11] defines Resilience as "the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change". This definition refers strongly to the definition of C.S. Holling (1973) and later Berkes and Folke 1998, Berkes et al. 2003 and Carpenter et al. 2005 on socio-ecological resilience. Applying the IPCC definition to the concrete issues of climate change and cities, climate change will cause disturbances on the city as socio-ecological system; but if the city is (climate-)resilient, it will be able to sustain its basic structure and ways of functioning – this also means its quality of life.

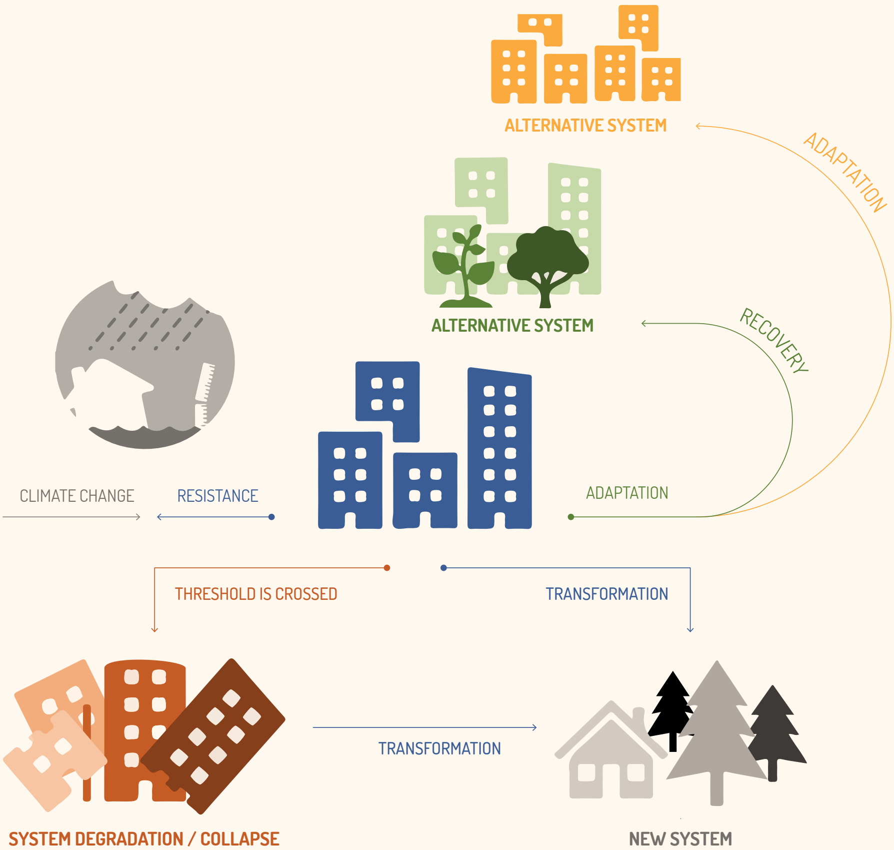


FIGURE 9: Climate resilience – see description in the text. Own illustration based on Fuller and Quine (2016)

The figure illustrates how a system like a city can react or adapt to climate change. It can adapt and recover as it is, or it can adapt to alternative systems e.g. by greening the city or optimizing its building structure and infrastructure. Although the city changes, its basic functions and structures are still sustained. A non-resilient outcome would occur if climate change causes such dramatic damages that it leads to demolished infrastructure and devastated areas, such that the city must transform into a completely new system. Politicians and planners try to prevent such disasters. Applying the concept of resilience can help to precautionary set the right measures.

FROM THEORY TO ACTION

BRINGING CLIMATE RESILIENCE TO THE NEXT LEVEL

Building on accomplishments, Vienna's Environmental Protection Department actively pushed the issue of urban climate change and took a leading role in developing an "Urban Heat Island Strategy Plan" for Vienna (UHI-STRAT). Completed in 2015 and one of the first plans of this kind, the city put itself in the front runner's position towards climate resilient planning.

Its main goal was to show planners, architects, and other relevant stakeholders a series of measures to reduce negative climate effects and to demonstrate appropriate mitigation and adaptation measures. Besides, the process of inter-sectoral discussions was essential for raising awareness on this issue.

To fill the UHI-STRAT with life, it was, and still is, essential to integrate it into the urban development practice of the city as found in both the city's strategic plans as well in local area plans. Current planning experience show that success implementation of UHI measures depends on transdisciplinary and integrative process setup and on stringent consideration over all relevant planning levels.

Since then, the UHI-STRAT has successfully been implemented in several planning documents. Examples for important fields of action include: the City of Vienna's Climate Protection Program; the Urban Development Plan - STEP 2025; the Public Space Concept; and, the management of measures within the framework of the Urban Development Plan and urban planning and building design competition processes.

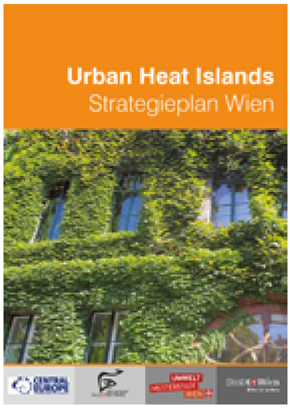


FIGURE 10: Urban Heat Islands Strategy Plan of Vienna, published in 2015 - one of the first plans of this kind

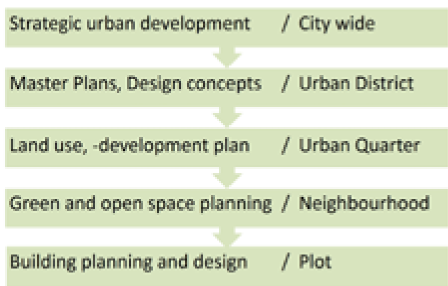


FIGURE 11: Planning levels in the City for the mitigation of the UHI effect.
SOURCE: from top to bottom: Stadtentwicklung Wien, Magistratsabteilung 18 – Stadtentwicklung und Stadtplanung, 2014, STUDIOVLAY; Stadtentwicklung Wien; Büro tilia; Jürgen Preiss, MA 22

NEW AND DEVELOPING CLIMATE RESILIENT TOOLS

Having identified the need to bridge the gap from the strategic side into the development realm, the city of Vienna, together with research partners such as AIT and local initiatives, has begun a series of projects to develop crucial insights into implementation processes and the methods needed to mitigate negative climate impacts. One of the on-going key projects[12] aims to develop a prototype tool set for the regulation, improvement, and evaluation of climate-sensitive urban planning in the city. In other words, the purpose of this project is to deliver scientifically proven findings which document how green infrastructure can contribute to the mitigation of the Urban Heat Island (UHI) effect in existing and planned quarters and to provide information about how to couple different planning tools at various scales. The proposed set of field-tested tools will allow the city to scientifically back planning decisions, allowing full transparency while making the impact of climate resilient planning measurable. Once completed, it will be a prototype multi-scale city planning tool for climate resilient urban planning.

Another important issue, being discussed in many cities, is the impact of urban densification on the urban climate. A recent AIT project named CLUDEX (Climate Change and Urban Densification impact EXploration) adapts the city's 3D model to develop urban densification scenarios for a particular Vienna district. It then assesses the impact of climate change and urban fabric change on indoor climate comfort and outdoor microclimate conditions. Citizens and stakeholders, including property developers, will discuss building-related and street layout adaptation measures to mitigate the densification impact on urban microclimate. Participants can choose from our tool box and select to test various adaptation measures, such as green roofs, green facades, green open spaces which can then be virtually tested to assess their impact under various microclimate and wind conditions caused by densification. The results will facilitate the establishment of climate sensitive densification guidelines.

IMPLEMENTATION WITH LIVING LABS

Besides the application of models and defining guidelines, AIT also has assisted the city to set up implementation test beds. These allow for a certain freedom of design, process and outcome, while testing under real conditions. The objective is to learn (about obstacles and features to be replicated) by actively involving the local population and stakeholders to ensure future acceptance of decided activities. For example, AIT, together with several partners, is setting up a living lab in the project "LiLa4Green" to test how the provision of green-blue infrastructure improves the climate resilience of a city. Another issue, worth being explored, are the costs to counteract the urban heat island-effects in areas where financial resources are low. This research can provide the justification to accelerate the provision of low cost remedial blue green solutions. However, the implementation of so called Nature Based Solutions (NBS) is facing challenges, such as priority for technical solutions and infrastructural needs (streets, parking lots, city sewer systems, etc.) as well as low acceptance or appreciation from the citizens.

To realize projects that not only strive for climate-friendliness but also consider social aspects (quality of life, health, safety, social equity, etc.), the focus of LiLa4Green is to develop a living lab to facilitate the involvement of users into the implementation process. It aims to bring the benefits of green-blue infrastructure nearer to the people and to raise awareness of the value and positive effects of greening the city. Participation and mutual learning are two crucial elements in the process to become a resilient city as they increase the societal acceptance, knowledge acquisition and thus adaptation capacity. Co-creation and experiments complement this process. By considering social aspects the resilience concept is extended. Besides the exposure of certain urban structures to climate change, the vulnerability of the local people living in the neighbourhood is addressed. This is particularly important in existing built-up and deprived areas. However, while this proposed lab is an important new issue, it has only recently been discussed in the context of climate change in the City of Vienna.

FIGURE 12: As space is scare, Vienna begins to use vertical surfaces for greening. Façade greening of a public building (MA31)

SMART AND RESILIENT VIENNA

Vienna's pioneering climate resilient urban planning can surely be considered a success. The circumstances of increasing urban growth and changing climate conditions provided a clear call for action. In addition to the support from the city government, an atmosphere of cooperation developed between the municipality and its research partners, such as the AIT, that has proven very productive. Jointly we are unlocking the complexity of the topic, developing a blue print for a climate resilient planning approach, and creating capabilities in this new field – all in a relatively brief time. Through the involvement of applied research partners and a scientifically based approach, the concerned stakeholders build confidence in the projects based on trust and professionalism. This confident partnership allowed the topic of climate resilient planning to be ingrained into the city's strategic plans and enables the team to gain experience with cutting-edge planning tools and in the implementation of measures in living labs.

The milestones we have accomplished can be considered a proper foundation and base to guide the next steps towards developing implementation appropriate criteria and related thresholds at planning standards appropriate at all scales. For the years to come, this will be one of the crucial tasks to tackle to establish a truly integrated climate resilient planning practice.

There are also issues which need the city's urgent attention, such as the elaboration of advanced urban climate maps displaying the city's climate functions, or the handling of climate caused cascading effects (e.g. malicious impact of heavy rain on public transport). Another key issue we need to address is the advancement of the governance structures. Current planning processes show that the success of implementing climate resilient measures depends on transdisciplinary and integrative approaches and on stringent consideration over all relevant planning levels. Giving an example for integrated planning, the City of Vienna launched a project in 2016 to promote façade greening. With the assistance of experts from all relevant interdisciplinary disciplines the legal requirements, the framework conditions, ecological, economic and social sustainability, best practices, quality assurance procedures, and implementation instruments are being defined. The issue of relevant fire protection is already finished and the new guideline for facade greening hopefully will be published this year (2018).

Besides the internal coordination within the City administration, a successfully realized resilient city also relates to how other stakeholders are involved in the entire planning process. Experiences in stakeholders´ processes, until now, have proven that balancing interests is not an easy task, since the understanding of, and the approach to the topic can vary widely. While companies want to climate

FIGURE 13: "Alt Erlaa" buildings from architect Harry Glück with generous green areas, spacious terraces and pools on the roof top. Already 40 years old but still popular for their high quality of life

proof their entire business environment, citizens request comfortable interior living environments with sound climate conditions. We are just beginning to develop stakeholders´ participation methods using crowd sourcing in the adaptation scenario assessment process. Further research and experience is required to learn how to involve all social classes, to identify how local requirements can be fulfilled, and to learn how the acceptance of implementation measures can be increased to achieve co-benefits.

Another key issue for the coming years will be the city's long-term commitment to implementation. To make this feasible, the support of concerned ministries to provide aiding policies and funding streams to support the city administration´s efforts is critical.

Climate events already have a direct impact on citizen's life and on businesses operating within cities. We think that being resilient will be a crucial factor if the city is to cope with rapid and unprecedented changes and continue to provide well working infrastructure and high quality of life in the long run. Therefore, a comprehensive approach towards climate resilient planning will play a vital role for the agenda of our cities.

FIGURE 14: Attractive settlement areas, mixed with social housing, along the Old Danube

In Vienna, this can already be observed in the debate on the further development of the smart city framework strategy. The strategy's close link to the urban development practice and its focus on sustainability and life-quality has proven highly successful. With the rising importance of climate resilience, it might turn out that Vienna's smart city strategy might soon become the city's smart and resilient strategy. That would be a major step in the right direction and secure the city's pioneering role.

ENDNOTES

1 The study evaluates local living conditions in more than 450 cities surveyed worldwide according to 39 factors, grouped in 10 categories, such as political, social, economic, and environmental factors. https://www.mercer.com/newsroom/2017-quality-of-living-survey.html

2 https://www.mercer.com/newsroom/2018-quality-of-living-survey.html

3 Vienna City Administration 2017

4 Magistrat der Stadt Wien 2017

5 https://www.zamg.ac.at/cms/de/klima/informationsportal-klimawandel/klimaforschung/klimamessung/messnetze-oesterreich

6 https://www.zamg.ac.at/cms/de/klima/klima-aktuell/jahresrueckblick

7 In 2017 28 tropical nights in the city centre, average (1981-2010): 15,5 tropical nights https://www.zamg.ac.at/cms/de/klima/news/drittwaermster-sommer-der-messgeschichte

8 https://www.aspern-seestadt.at/en

9 aspern Seestadt recently won the "immobilienmanager award 2018", the most prestigious prize of the property developer community in the german-speaking countries! https://www.aspern-seestadt.at/presse/aspern_seestadt_erhaelt_immobilienmanager_award_2018

10 http://info.tuwien.ac.at/urbanfabric/index.php/en/

11 IPCC WG2 2007: 880 (Parry et al. 2007)

12 "Green.resilient.city" https://nachhaltigwirtschaften.at/en/sdz/projects/green-and-resilient-city.php

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COOL PLANNING FOR ZERO EMISSION NEIGHBORHOODS

THE NORWEGIAN WAY

DANIELA BAER, ARILD GUSTAVSEN, INGER ANDRESEN

FIGURE 1: Views of the City of Bodø. PICTURE by Bjørn Godal

INTRODUCTION

The objective to reduce both greenhouse gases and energy use is one of the most important measures to meet the UN climate goals of limiting global temperature rise to 2 degrees Celsius[1]. Cities need to play a key role in finding the right answers to climate change, as they host most of the world's population and are responsible for most of the global climate gas emissions. Buildings and construction account for more than 35% of global final energy use and nearly 40% of energy-related CO2 emissions[2]. One critical method to mitigate climate change is to improve energy efficiency in the building sector.

While progress was made on new construction by developing nZEB[3] buildings in many countries in Europe during the last decades, little was done to improve the energy consumption and greenhouse gas emission of planned and existing buildings at the neighborhood level. Here, the focus is not on individual buildings, but on a system of buildings and infrastructure within a geographical boundary. The reduction of CO2 emission results from the interplay of the three elements of buildings, infrastructure and human action. Reducing CO2 emissions at the neighborhood level, requires increased attention to CO2 mitigation strategies, energy efficiency and flexibility, while simultaneously developing the quality of the buildings and surroundings in which people spend their daily lives.

Despite Norway's commitment to produce most of its energy with renewable sources, many people - even Norwegians - resisted the idea of Zero Emission Neighborhoods. But the list of reasons for the implementation of Zero Emission Neighborhoods is compelling, such as the reduction of the energy peak loads and the creation of self-sustaining neighborhoods; all of which will lead to more sustainable and resilient neighborhoods and cities. Experience has shown that Norway can develop Zero Emission Buildings and even go further by deploying a life cycle assessment methodology accounting for emissions.

This article will tell the story about Norway's progress in developing Zero Emission Buildings and Neighborhoods from a research point of view. The starting point is the concept of Zero Emission Buildings, which is expanded to the concept of Zero Emission Neighborhoods. The article will end with a snapshot of the pilot projects of the Research Centre on Zero Emission Neighborhoods in Smart Cities and ongoing research related to the projects.

STARTING AT THE BUILDING LEVEL: ZERO EMISSION BUILDINGS

As an answer to the goal of greenhouse gas reduction, governmental energy efficiency requirements in buildings were increased in the last decades all over Europe. A decade ago, this was the starting point, for the Research Centre for Zero Emission Buildings (ZEB-Centre)[4] at the Norwegian University of Science and Technology (NTNU)[5] in cooperation with SINTEF[6]. Our research was focused on advanced materials technologies, climate-adapted low-energy envelope technologies, energy supply systems and services, energy efficient use and operation, and concepts and strategies for Zero Emission Buildings. Research was adopted to nine real buildings pilot projects, with seven buildings already completed, including offices, educational buildings, and single family detached houses. The results after 8 years of research (2009-2017) provided the proof that it is possible to design and build zero emission buildings within the Norwegian cold climate.

DEFINITION OF A ZERO EMISSION BUILDING

Conceptually, a zero energy building is a building with a greatly reduced energy demand, such that this energy demand can be balanced by an equivalent generation of electricity (or other energy carriers) from renewable sources. All new buildings in the EU are supposed to be nearly zero energy (nZEB) by 2020.

But the definition of the nZEB level is not clearly defined and it is up to each member country to set the requirements within the national legislation framework. The requirements we established for our pilot building projects were considerable more ambitious than the nZEB level, as we also considered greenhouse gas emissions through the entire life cycle of the building. In a Zero Emission Building in

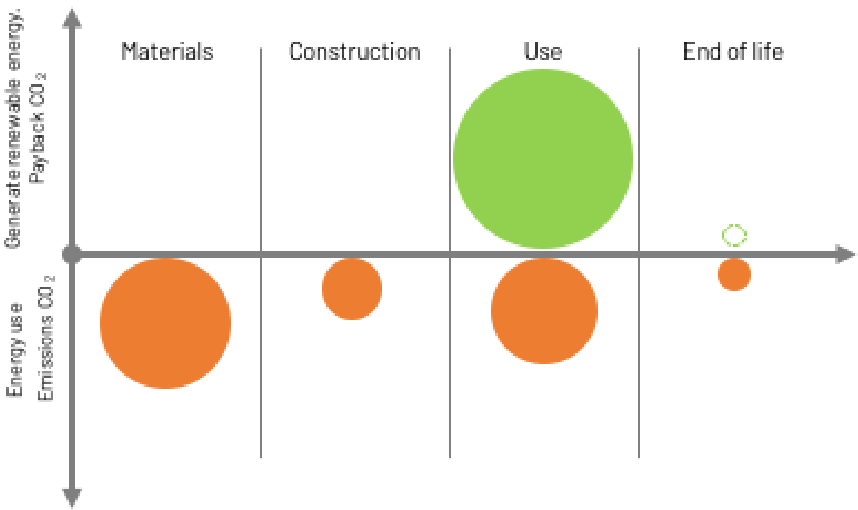

FIGURE 2: Illustration of the emissions balance of a Zero Emission Building. SOURCE: Selamawit, M.F. et al. (2016)[8]

the Norwegian ZEB Centre, such a balance is not achieved directly on the energy demand and generation but on the associated greenhouse gas emissions, including GHG-emissions over a building's lifetime. Emissions from the production of materials, construction, operation and demolition were all included in the balance. These emissions must be compensated for by production of renewable energy onsite[7].

Figure 2 is an illustration of a fictitious emission balance for a Zero Emission Building. Emissions are displayed in the four life cycle phases of a ZEB related to building materials, construction, use/operation, and demolition phases. The circles indicate the relative size of the emissions produced or compensated for in each of the phases. Results from our pilot buildings indicate that the embodied emissions may exceed the emissions from operation. Also, the results indicate that the emissions from the production of the materials are far more significant than the emissions from the construction phase. In the case of demolition, there may also be some energy gained, for instance by the incineration of waste, as indicated by the dashed green circle.

LESSONS LEARNED WHEN PLANNING FOR ZERO EMISSION BUILDINGS

In all the ZEB pilot buildings projects, an Integrated Energy Design (IED) process has been used, as planning for energy and emissions reductions must be integrated early within the design process[9]. The challenge is to integrate energy measures as a part of the architectural design, with linkages between the different design elements like building form, façade design, and building fabric. Changes and improvements are relatively easy to make at the beginning of the process but become increasingly difficult at a later stage. Nine main steps could be identified to be crucial when planning for zero emission buildings[10]:

1. From day one, select a multi-disciplinary design team who are skilled in energy/environmental issues and who provide close cooperation and openness.
2. Analyze the boundary conditions of the project and the client's needs and demands to formulate a set of specific goals for the project.
3. Make a Quality Assurance Program and a Quality Control Plan for follow-ups throughout the project.
4. Arrange a kick-off workshop to make sure that all the team members have a common understanding of the design task.
5. Facilitate close cooperation between the architects, engineers, and relevant experts throughout co-localization and a series of workshops during concept design phase.
6. Update the Quality Control Plan and document energy performance at critical points (milestones) during the design.
7. Make contracts that encourage integrated design and construction.
8. Motivate and educate construction workers and apply appropriate quality tests.
9. Make plans for follow-up of operation and maintenance of the building.

This design process was adopted to all the ZEB pilot building projects and helped to achieve the targeted goals.

ONE STEP FORWARD: ZERO EMISSION NEIGHBORHOODS (ZEN)

However, focusing solely on individual buildings can lead to suboptimal solutions when aiming for a zero emission target. For some buildings it may not even be possible to achieve the zero energy or emissions targets, either because energy demand cannot be reduced sufficiently or because of lack of access to renewable energy on-site.

Another consideration is that different building categories have different use patterns that can produce benefits. For example, office buildings are used during the day while residential buildings are used in the afternoons and evenings. The residential buildings can be used as solar powered power-banks for the offices during the day. During the afternoons and evenings, the tides of power may shift direction, going from the offices to the dwellings. Looking at the neighborhood scale, not every building might be a Zero Emission Building, but as a group with the benefit of dynamic distribution of loads between the buildings, they may reach it as a group[11].

Also, developing Zero Emission Buildings in a system - at the neighborhood level – should not be addressed solely to achieve Zero Emission for that neighborhoods. Other elements like such as mobility, spatial qualities, and the connection to larger region are important aspects to address when planning and developing Zero Emission Neighborhoods.

WHAT IS A ZERO EMISSION NEIGHBORHOOD

In the ZEN Research Centre, a neighborhood is defined as a group of interconnected buildings with associated infrastructure, located within a confined geographical area. A zero emission neighborhood aims to reduce its direct and indirect greenhouse gas (GHG) emissions towards zero over the analysis period. The neighborhood should focus the following, where the first five points have direct consequences for energy and emissions[12]:

a. Plan, design and operate buildings and their associated infrastructure components to minimized life cycle GHG emissions.
b. Become highly energy efficient and become powered by a high share of new renewable energy.
c. Manage energy flows (within and between buildings) and exchanges with the surrounding energy system in a flexible way.
d. Promote sustainable transport patterns and smart mobility systems.
e. Plan, design and operate with respect to economic sustainability, by minimising total life cycle costs and life cycle system costs.
f. Plan and locate amenities in the neighborhood to provide good spatial qualities and stimulate sustainable behaviour.
g. Development of the area should be characterised by innovative processes based on new forms of cooperation between the involved partners leading to innovative solutions.

The Zero Emission Neighborhood definition work will be an ongoing process throughout the program period (2017–2024), as different specifications and solutions in the different work packages and pilot projects are tested and honed.

THE RESEARCH CENTER OF ZERO EMISSION NEIGHBORHOODS IN SMART CITIES (ZEN CENTRE)

The ZEN Centre[13] is hosted by the Norwegian University of Science and Technology in cooperation with SINTEF and financed by the Norwegian Research Council. It will last from 2017 until 2024.

The goal of the Research Centre on Zero Emission Neighborhoods in Smart Cities (ZEN) is to enable the transition to a low carbon society by developing sustainable neighborhoods with zero greenhouse gas emissions. The ZEN Centre will speed up decarbonization of the building stock (existing and new), use more renewable energy sources and create positive synergies among the building stock, energy, ICT and citizens. Covering the entire value chain, the ZEN Centre will develop a joint approach with industry and public partners to create new and transform existing areas into sustainable, zero emission neighborhoods.

Our research is closely linked to the nine neighborhood development projects in Norwegian cities which are pilot projects within the centre. The pilot project areas represent a population of approximately 30,000 people and have a built floor area of more than 1 million m2. The reduced greenhouse gas emissions will quantify to at least 10,000 tons per year by 2025, with an investment of about 26 billion NOK[14].

ZEN PILOT PROJETS

FIGURE 3: Ilustration of the 9 pilot projects of the ZEN Centre. Illustrations and pictures: tegn3, a-lab, Bodø Municipality, Kjeldsberg Eiendom, Koht Arkitekter, Steinkjer Avisa, Snøhetta/Mir, Statsbygg, Wilhelm Joys Andersen (from left to right)

Planning for energy and emission reduction and developing ZEN is a multi-stakeholder challenge with new stakeholders on the agenda and the need for new planning and design approaches. The Centre attempts to represent the entire value chain with partners from all different stakeholder groups: from municipal and regional governments to property owners, developers and housing associations, consultants and architects, ICT companies, contractors, energy companies, manufacturers of materials and products and governmental organizations.

The ZEN Centre aims to empower citizens and re-think the way in which inhabitants, users and neighbors can contribute to plan, create and manage their buildings and neighborhoods, to enable public support and every-day achievement of ZEN goals.

The work of the ZEN Center is divided into 6 working packages (WP).

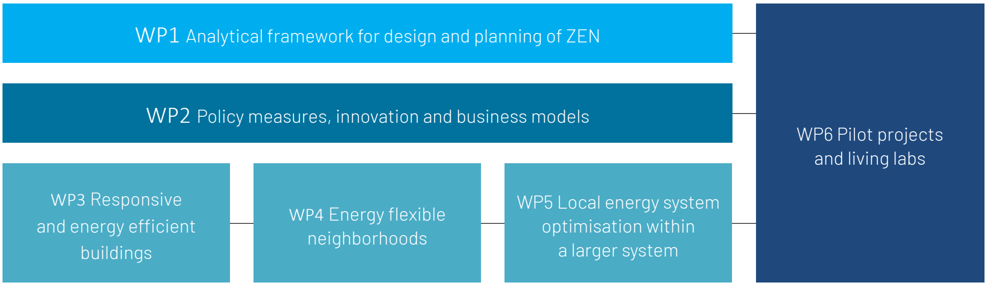

FIGURE 4: The six working packages of ZEN Centre

WP1 Bridging the carbon knowledge gap from research to design. We will attempt to break existing high-carbon path dependencies, by integrating science-based knowledge on greenhouse gas emissions into practice-based neighborhood design and planning instruments.

WP2 Creating policy models which support long term transitions towards ZEN by creating new business models, roles and services in the value chain that address the lack of flexibility towards markets and catalyze the development of innovations for broader public use.

WP3 Proto-type responsive and energy efficient buildings with low carbon technologies, construction systems and design tools based on lifecycle design strategies to reduce the GHG emissions from buildings and to enable energy flexibility.

WP4 Facilitate energy flexible neighborhoods to develop solutions for flexible management of local distributed energy sources in neighborhoods. These include thermal and electric systems and the interplay between them, to avoid costly reinforcements of distribution grids while improving the quality and reliability of supply.

WP5 Develop local energy system optimization within a larger system and expand a decision support tool (eTransport, www.sintef.no/en/projects/etransport/) with new technology options for buildings and local production. This will enable analyses of the optimal operation and development of ZEN energy systems, which is not possible in existing planning tools.

WP6 Create and manage pilot projects and living labs for a series of neighborhood-scale living labs in nine Norwegian cities and communities. These pilot projects will act as innovation hubs and testing ground for the solutions developed in the centre.

CHALLENGES TO PLAN FOR ZERO EMISSION NEIGHBORHOODS

Through interviews with central stakeholders in the development projects, as well as the study of relevant documents, we have identified 10 main challenges in the projects[15]:

1. Project organization and management: How to ensure continuous process management given the long time-frames of the projects. How to ensure commitment to ZEN goals among all participants (different landowners, public and private developers, contractors, end-users, etc.). How to implement new inter-disciplinary ways of working.
2. Lack of knowledge: There is limited knowledge about how to plan, develop, construct, and operate a ZEN.
3. Legislation: Current codes and regulations are not adapted to the ZEN solutions, with respect to the exchange of energy between buildings.
4. Goal conflicts: How to handle conflicting interest of different stakeholders, i.e. developers, municipalities, citizens, etc.
5. Time and cost pressure: Even though the development projects have long time frames, the projects are still subject to limited time and resources, which makes it demanding to take into account the added complexity of ZEN projects.
6. New energy technologies: How to select, design, and integrate the most suitable new energy supply systems with the lowest possible carbon footprint and life cycle costs given a lack of methods, tools, and data.
7. System boundaries: What emissions should be included in the calculations, and how. What is the needed level of detail. How to consider energy plants located outside the development area.
8. Risks and uncertainties: How to handle risks given: the large uncertainties (long time frame) of the developments; changes in boundary conditions (e.g. regulations and incentives); new technologies developments; and, uncertainties about the costs and performance of ZEN solutions.
9. Flexibility: How to plan the infrastructure to allow for flexibility and adaptation to future developments in technology, legal frameworks, and use.
10. Transferability: How to transfer the knowledge and solutions developed in the pilot project to other neighborhood developments.

BEFORE AFTER

FIGURE 5: Aerial view of the planned development in the "New City - New Airport" project in Bodø.
SOURCE: Bodø Municipality

CURRENT RESEARCH WITHIN THE ZEN PILOT PROJECTS

STAKEHOLDER ENGAGEMENT IN BODØ

The airport within the city of Bodø will be relocated creating about 340 hectares of inner-urban land for development. The goal of the development of the “New City - New Airport” project is to develop a compact city district well connected to the existing city with a high living environment, combined land use, attractive walking and cycling networks. The project is embedded within the smart city strategy of Bodø.

URBAN PLANNING TOOL FOR ZEN

The urban planning tool, which is under development enhances the ability to design for sustainability by improving the understanding of the built environment with its complex and dynamic interrelations of its components[16]. As a data management tool, and with help of the design concept of “serious play”, it can transparently manage and integrate data from different sources.

The tool consists of a 3D model of the city and is currently focusing on energy analysis. Shortly the key performance indicators (KPIs) of ZEN are planned to be incorporated into it. These KPIs are currently under development within the research center of ZEN. KPIs will be developed for each of the 7 aspects of the ZEN definition (see above). Integrating these KPIs into the urban planning tool gives planners and stakeholders the possibility for a better assessment of planning and design decisions as new assessment criteria, as emissions, are operationalized. It enables users to visualize alternatives and their impacts on the KPIs. With this

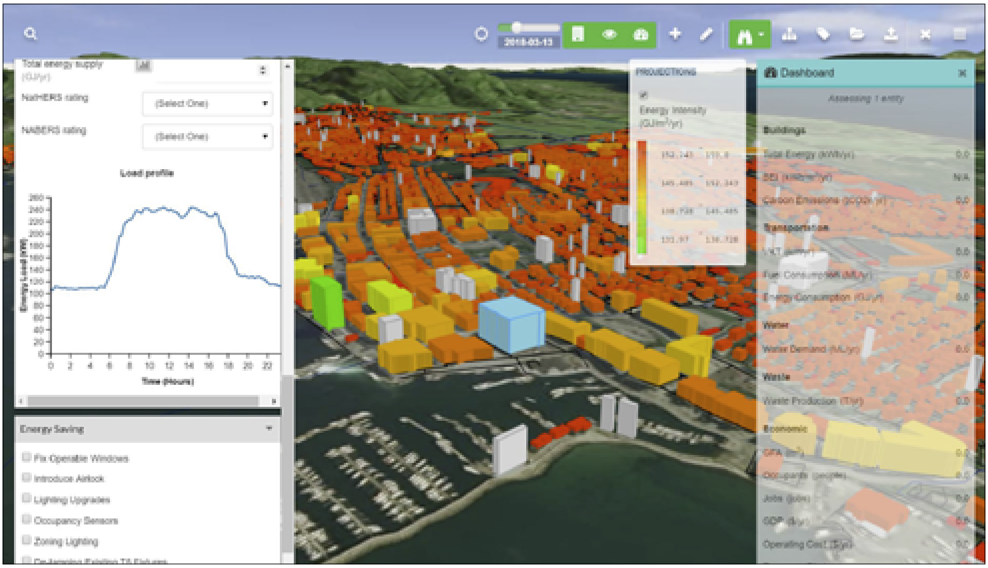

FIGURE 6: Screenshot of the planning tool for ZEN. SOURCE: Bodø Municipality

ability it is expected to provide stakeholders with a broader basis for holistic and integrated planning decisions.

In the future the integration of the planning tool with Bodø's own IoT platform will enable the access to real-time sensor data.

BODØ BYLAB

The city of Bodø is experimenting with new form of stakeholder engagement by establishing a city lab, the Bodø ByLab. The ByLab consists of a virtual and physical platform to test and implement future-oriented participation processes within its smart city strategy, especially the 'New City – New Airport' project.

The planning process has recently started for the new airport, which is to be opened in 2025. As part of this project, Bodø is testing two new ways for stakeholder engagement by using an urban planning tool and by using the ByLab (CityLab).

The virtual platform on www.bodobylab.no, will facilitate easier access to information about urban projects and opportunities to become involved into them. Employees of the municipality, citizens, and other actors in Bodø can start own projects and create groups at the platform and thereby create easier and faster communication between the city administration, business sector and citizens in Bodø. For example, users can define a geographical area of interest within the city and whenever a planning process starts or a project on platform created within that area, they will automatically be informed about ongoing process and possibilities for participation.

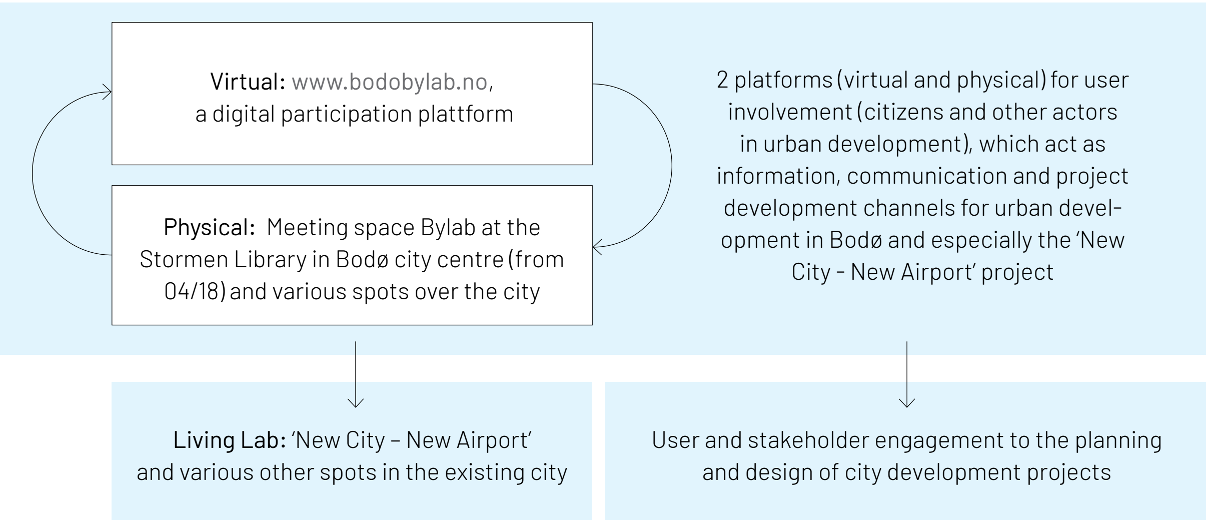

FIGURE 7: Structure of the Bodø ByLab

The ByLab will also test new forms of engagement with stakeholders outside the administration. But it will as well prepare and increase the competence of the municipality's employees for new future working methods and cooperation across the departments, which is an important factor for successful planning for ZEN.

The physical ByLab was opened at the beginning of April 2018 at the Stormen library located in the city centre of Bodø. The Bylab is a physical meeting space for stakeholders involved in urban city developments. With a focus on citizens, the library was chosen as its location to make it easier for citizens to join. The ByLab will start with presenting the planning for the 'New City – New Airport' project with employees from different departments of the municipality being present at the ByLab in different shifts. The physical lab will also demonstrate that the municipality is thinking of new ways for the municipality's employees to work and be organized. The work tasks and the departments do not control who work together and this will benefit the inhabitants of the municipality. In the future, it is planned that stakeholders can dunk into the digital 3D-model of the city with VR glasses. The link of this model to the ZEN tool will give stakeholders a much better understanding for the planning.

ByLaB Bodø will contribute to ensuring a sufficient degree of citizen involvement and commitment to the development of a smart city today and in the future in line with the "New City- New Airport" project. ByLab Bodø will be the first municipal-scale concept of its kind in Norway. Experience and conclusions from ByLab Bodø will form the basis for the creation of a permanent lab in new town hall in 2019.

FIGURE 8: Impressions from the opening of the Bodø ByLaB. PHOTOS BY Daniela Baer

The ZEN Centre, especially WP 1 and 6, will also contribute to the testing the Bylab for stakeholder engagement by identifying crucial stakeholders in the different phases of development and in the developing of formats for stakeholder engagement such as sustainable experiments (see below).

SCENARIO-BASED PLANNING IN FURUSET

Furuset, an existing urban neighborhood in the Norwegian capital Oslo, built in the 1970s, is now conducting a renewal process with emphasis on sustainability. It has been chosen as a lighthouse project to cut emissions by 50% by 2020 and 95% by 2030. The renewal takes into consideration water, traffic, green landscaping and social issues, creating 1,700 to 2,300 new housing units and 2,000 to 3,400 new work places. The development includes the establishment of a thermal micro-grid utilizing excess heat from cooling and ground source storage.

During the PI-SEC project[17], a complementary research project about Smart Energy Communities, the 'KPI planning tool' was developed as an Excel application. It is now being tested and improved by the ZEN Centre because of its use in Furuset. It gives urban planners and other stakeholders the opportunity to evaluate alternative scenarios, to reach the targeted goals of emission reduction within a neighborhood development. It calculates energy-related KPIs such as energy consumption in different sectors and sources, energy efficiency indicators, and energy generation. Altogether the tool consists of 21 indicators which are the background for a holistic evaluation of development and transition pathways in the development.

FIGURE 9: Planned central street in ZEN pilot project Furuset.
ILLUSTRATION by the Planning Department of Oslo Municipality

The tool is intended to work with different scenarios. A baseline scenario will be defined with energy consumption for renovations and new buildings according to prevailing regulations. A development scenario assumes more ambitious planned energy performance levels. When the scenarios are defined, the tool can calculate the results which will be shown in set of charts, based on the chosen indicators (see Figure 11). The results will give important insights about what measures and ambition levels are necessary to reach the project targets. After the evaluation, modifications to scenarios can be made, or new scenarios can be defined before the system is recalculated[18].

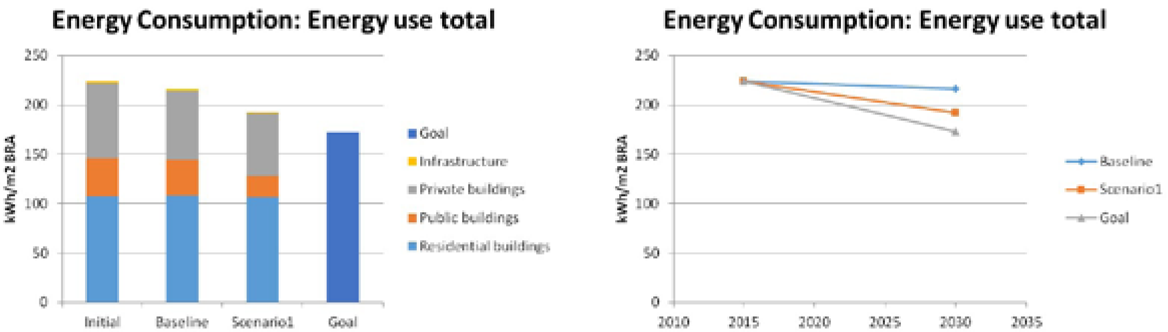

FIGURE 10: Example charts for energy consumption from KPI planning tools, case of Furuset[19]

SUSTAINABLE EXPERIMENTS WITH USERS AT THE NTNU CAMPUS IN TRONDHEIM

NTNU in Trondheim has started a unifying process of their multiple campuses. To achieve this, it needs to enlarge the remaining campus by 136,000 m2 of floor area to accommodate 17,000 relocated and new users. The main goal of the campus unifying project is to develop a campus that provides the best environment for excellent research, education, dissemination, and innovation and that achieves net zero greenhouse gas emissions by 2060.

The NTNU campus was the test site of the first series of sustainable socio-technical experiments with people on the campus. We know that people's behavior and practices in their daily life have a strong impact on the amount of greenhouse gas emissions generated. Therefore, people living and working in

FIGURE 11: Illustration for the construction on the west side of the campus. ILLUSTRATION by Koht Architects

FIGURE 12: The Living Lab as first Zero Emission Building on the NTNU Campus in Trondheim. PHOTO by Daniela Baer

ZEN neighborhoods must be addressed, in addition to the development of new technologies to create effective zero emission neighborhoods. Qualitative experiments are one methodology tested to create greater ownership in the process of developing a zero emission campus at NTNU. These experiments also foster dialogues and discussion around zero emissions lifestyles. The outcomes of the experiments give planners important insights about users attitudes and practices towards ZEN.

Three experiments were run on the campus during autumn 2017. One experiment with participants visioning and developing scenario about the future ZEN campus. At one of these sessions participants developed ideas for a future life on a zero emission campus with urban gardening and re-use of resources. In a second experiment a low-tech classroom was created to examine what effect limiting technology has on activities taking place in the classroom. As one result, lack of access to internet fostered dialogue and critical thinking among participants and fostered new ways of engagement in the classroom. The third experiment constructed a working day within a Zero Emission Building. We found that the characteristics of the building with natural materials and its construction materials were important factors for the overall well-being of the participants[20].

In total, the findings from the experiments gave important input into the early design phase of the future zero emission campus with application for the future. This first series of experiments was a starting point for further experiments conducted in the several pilot projects under the guidance of WP 6 in the ZEN Centre.

THE ROAD AHEAD

In coming years, the involved cities, public organizations, industry and research partners will work together in the ZEN center to develop better solutions to plan, design and manage zero emission neighborhoods. Innovation will take place and will spread from the pilot projects over the country and even further. Besides technical solutions to build and maintain building and infrastructure as well as energy production on site with zero emissions, new business models and solutions to plan and design for ZEN will be developed. A toolbox integrating different tools will be developed to help to plan, design, manage and monitor the neighborhoods based on the ZEN Key Performance Indicators. This toolbox aims to be user-centered and will consists therefore of tools to improve stakeholder and especially citizen engagement during the different phases of development. All the involved partners are sure about one thing, the vision of ZEN can only be realized with the cooperation with all partners and users.

More is to come. Please follow us on our webpage www.zenresearchcentre.com.

ENDNOTES

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UNSUSTAINABLE HUMAN SETTLEMENTS
NEW URBAN INHABITANTS, NEW EXPOSURE

MICHELE MELCHIORRI, ANETA J. FLORCZYK, DANIELE EHRLICH

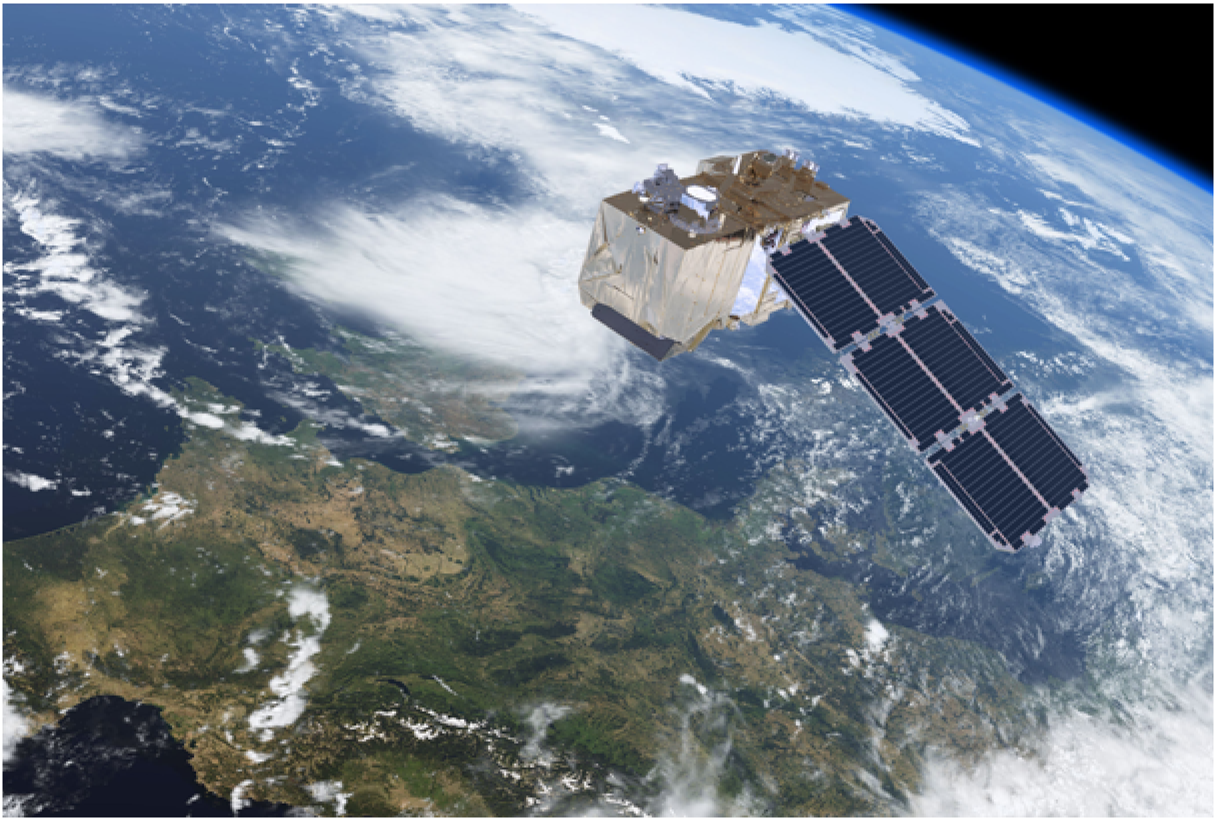


FIGURE 1: Sentinel-2 brings land into focus. SOURCE: ESA

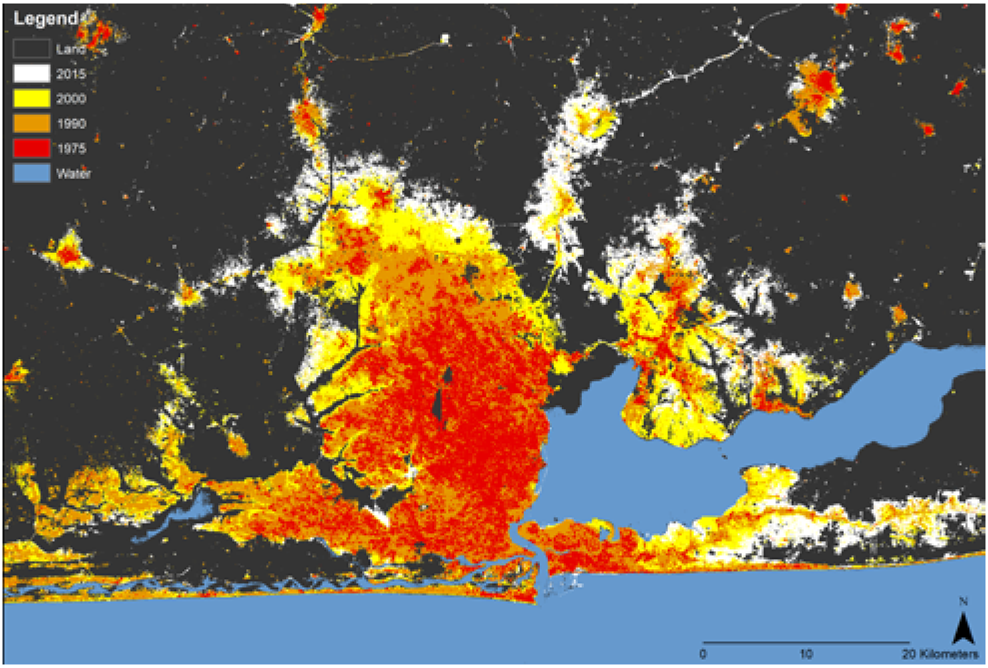
INTRODUCTION

Global population has almost doubled since 1975, totalling 7.2 billion people[1] in 2015. More than 90% of this growth occurring in urban areas as demographic, economic and societal transformations mutually reinforce this process. This expansion of urbanized settlements is a planetary phenomenon[2]. It is salient for planning policy and practice, and it generates interdependence among many policy sectors. Despite the challenges a global knowledge of urbanization has yet to be established.

As global population peaks, the impacts of humans on the planet become increasingly evident both in the form of extreme weather events which cause natural disasters, and in terms of climate change manifestations such as sea level rise and the increase in the average global annual temperature[3].

The interplay between population growth and climate change often results in increased exposure of people and assets to natural hazards. Although disaster risk management has surged in many policy frameworks at various levels, natural disasters continue to cause loss of human lives and the disruption of assets. Adequate intelligence is needed to improve the resilience of societies.

Exposure is reported to be the biggest determinant of disaster risk[4]. However, the knowledge and understanding to accurately quantify societal exposure to natural hazard is limited, but current approaches enable an assessment of the current



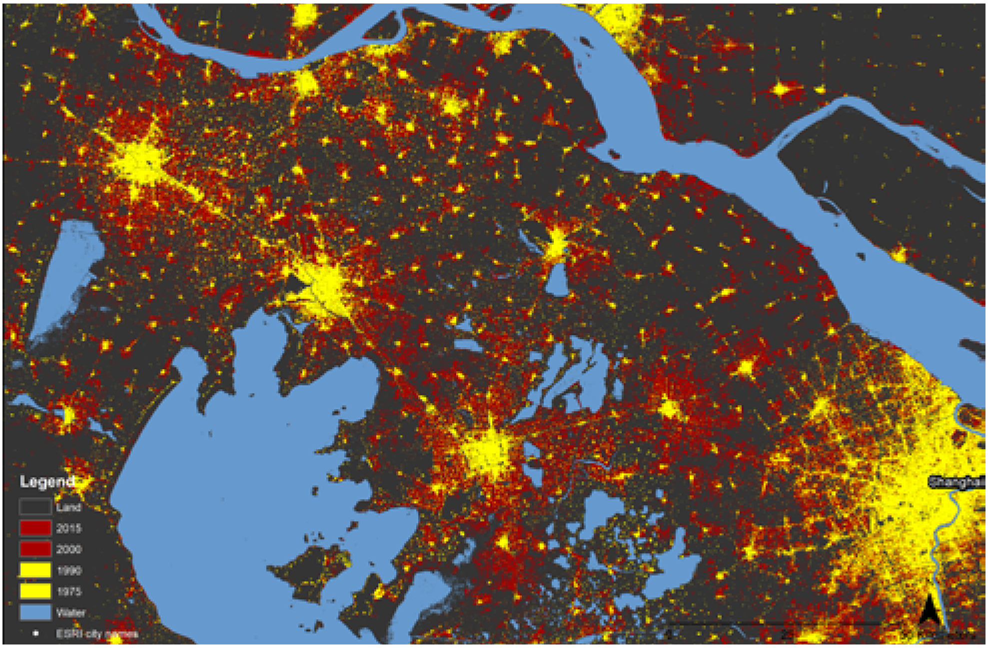


FIGURE 2: ↑ Multi-temporal built-up areas map of Lagos (Nigeria). Colours correspond to built-up areas mapped in the Global Human Settlement Layer (BUILT layer). The map highlights the substantial spatial expansion that took place in Lagos in the last 40 years

FIGURE 3: ↓ Multi-temporal built-up areas map of Shanghai, and Suzhou, Wuxi, Changzhou (China). The image displays the substantial spatial expansion of built-up areas between 1990 (yellow) and 2015 (dark red)

degree of exposure to natural hazards. One method, commonly used to quantify exposure, maps the location of settlements, what their characteristics are, how they evolved over time, and then overlays this information with maps that mark the spatial extent of hazards for a certain return period. For example, human settlements located in low lying coastal areas or near streams, rivers, or the sea coast likely have a higher risk of damage from sea level rise or flooding. Despite our ability to assess risk, the growth of human settlements in zones potentially prone to natural hazard continues and poses strong concerns for the safety of residents of these areas. This continued practice represents an unjust creation of new risk along with the development of these new human settlements[5]. Until recently, a global knowledge on the spatial expansion of human settlements and their population dynamics was not available. At the Habitat III conference the European Commission - Joint Research Centre made this information available open and free to all with the release of the Global Human Settlement Layer [6].

AN EYE ON EARTH, FROM NUMERIC IMAGERY TO KNOWLEDGE

The use of satellites has proven to be particularly suitable for mapping exposures. Using new technology-based tools and the competency of scientists at the European Commission's -Joint Research Centre, a global map of human settlements has been created and is available to support decision making and build a new understanding of the global urban condition[7].

Earth observation, both from aerial photography or satellite platforms, is an important measurement tool to gather information about planet Earth. Specific thematic branches and measurement devices observe the spatial size, form, and density of cities and settlements. Initially aerial photography was the preferred and only tool to observe cities and settlement from above, but in the past few decades satellite and space-borne platforms have started collecting images of the Earth surface.

Today, sensors on satellites produce a daily wealth of information and have been doing so for the last 40 years. The key advantages of data sensed (remotely) by satellite are: the global coverage (including remote areas); the continuity of service (repeated information acquisition); the relatively low marginal cost; and, the endowment with adequate spatial resolution for several applications[8]. On the contrary, aerial photography requires ad hoc and continuous aerial photo acquisition missions that can be expensive, are typically carried out based on government funding; and, are not always focusing on the areas of interest to other users.

Satellite-based earth observation for civil application and scientific use started

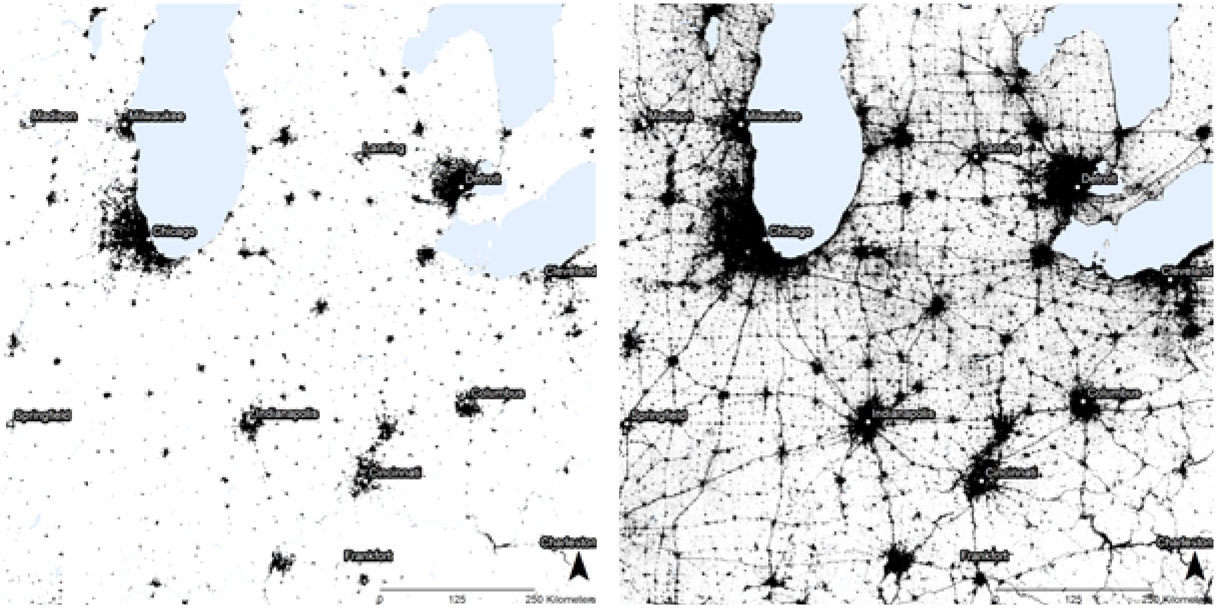


FIGURE 4: Comparison of MODIS 500m delineation of human settlements (left), and GHSL BUILT Layer (right) at the year circa 2000. In the area of Chicago with GHSL it is possible to map also smaller settlements and fringes. Moderate resolution products are however suitable for global, high abstraction applications

in the 1970's with the Landsat Program, managed by the United States Geological Survey (USGS) and the United States National Aeronautics and Space Administration (NASA). This program is still operating today. The first Landsat satellite was launched equipped with two sensors that started collecting information to support studies in the field of cartography, agriculture, geology and planning. During the past decades, the consecutive Landsat missions sourced images, first at coarse spatial resolution, then at moderate resolution (today). The data – with spatial resolution between 30 and 75 metres – could serve high abstraction delineation of human settlements, especially larger urban agglomerations. These sensors were mostly used to produce land cover maps[9], that made it possible to discriminate artificial/sealed surfaces. While not the ideal sensors for detailed territorial analyses, this coarse data has been useful in the systematic analysis of urban areas globally.

From the 1970s until recently, only coarse resolution (below 100m) Landsat images were available as open data. As of 2000 very high resolution (VHR) satellite image are being collected and archived from a new generation of satellites and sensors, especially commercial platforms like SPOT ("Satellite Pour l'Observation de la Terre), or the DigitalGlobe constellation (Ikonos, QuickBird and the WorldView serie). The VHR imagery possess a spatial detail which allows the detection and measurement of single buildings and is often used instead of aerial photography, especially in areas that are difficult to fly to or access. However, the benefits of higher spatial detail often come with additional costs, especially license agreements, the cost to access the imagery, and indeed the higher requirements in terms of computational, processing, and storage capacity.

Despite these costs VHR platforms, available through Public programmes, have become a major source of information to map settlements. VHR now is often available for visualization purposes on global web platforms that include Google Earth, and Bing. However, the data contained in these platforms is copyrighted and cannot be used and processed in a quantitative way for human settlement analysis.

Fortunately, the constellation of satellite earth observation and image archives that store the images of the earth surface continues to grow. For example, the Copernicus program of the European Commission[10], has orbited a constellation of EO satellites that collect optical images as well as radar images, which can be considered a continuation and an improvement of imagers available from the Landsat program for the following reasons. First, the data are open source, like Landsat, and can be downloaded by the global community of users; second, the spatial detail is an improvement over that of Landsat allowing the detection of built-up area and human settlements; third, the data are available as optical images that also include infrared information – similar to some aerial photography – as well as Synoptic Aperture Radar (SAR) data that allow imaging of the earth surface during periods of cloud cover.

The combination of optical and SAR datasets is ideal for crises management as it provides the opportunity to monitor the impact of most hazards. In fact, the data are routinely used by the European Commission Copernicus Emergency Service[11] to generate information products during different phases of a crisis. For example, it is used to identify the disaster areas of events which change over time, such as flood extent, land slide extent, and volcanic eruption.

The huge amount of information remotely sensed from satellites, and the need for rapid mapping to respond to crises, has challenged scientist to develop computer-based algorithms able to process this wealth of information. A selected number of research teams have engaged in automatically processing entire image archives. Automatic processing and machine learning made it possible to upscale the processing of information to delineate built-up areas from selected areas of interest (i.e. for emergency response) to the global scale (i.e. for scientific use and policy support). For example, the Global Human Settlement Layer (GHSL) project at the European Commission- Joint Research Centre (JRC) has processed the entire Landsat archive to produce built-up area maps that define

FIGURE 5: Comparison of remote sensing imagery from different satellite sensors, moderate Landsat resolution (left), decametric (Sentinel 2 centre), and VHR (right). Higher resolution images are better input data for built-up areas detection, but are subject to licensing and requires complex computational, processing, and archiving systems. The image refers to Bodo, Norway

the spatial extent of human settlement for reference years 1975, 1990, 2000 and 2015. These maps are available as open source data.

The GHSL project also has started to process archives of Sentinel imagery that will deliver the next generation of global built-up maps in the coming future[12]. The new JRC maps will be essential to monitor urbanization as the technology can capture most manifestations of human presence, from hamlets to megacities. The GHSL product has also combined built-up layers with population census information to obtain population density at fine spatial scale suited for urbanization and crisis management applications. The procedure disaggregates the population data from coarse administrative units into small spatial units, typically in the form of grid cells, based on the built-up area contained in each cell. The two layers (built area and population density) are used to determine global exposure in crisis management and in disaster alert systems. The two layers are also used for disaster risk assessment, a key requirement in the Sendai Framework for Disaster Risk Reduction as well in the Paris Agreement. These same maps are also used to measure the land consumption within the context of the Sustainable Development Goal 11. Finally, the two layers can be used for quantifying the dynamic growth of human settlements, and as such are key essential data layers for the implementation of the New Urban Agenda.

MAPPING EXPOSURE OF PEOPLE AND THEIR SETTLEMENTS TO NATURAL HAZARDS

Based on the analysis of satellite images, the JRC has produced fine scale, global, human settlement information to account for the rapid growth of settlements due to urbanisation. The extraction and analysis of information, derived from satellite images and census data, is transformed into knowledge used to inform policymaking, improve resilience of societies, and take risk informed decisions. Settlement maps are used by both disaster risk management practitioners and policy makers to identify areas exposed to natural hazards and to quantify the exposed elements.

In support of policy research by the Science and Knowledge Service of the European Commission, the Joint Research Centre produced the first scientific estimates of global exposure of human settlements to natural hazard. This product was named “Mapping human settlements exposure to natural hazards”[13]. Exposure was quantified by measuring, mapping, and monitoring the spatial location of human settlements and their population. Settlement information needs to be precise because disasters occur in specific locations. In practice, exposure was quantified by overlaying natural hazard maps (earthquake, volcano, tsunami, flood, tropical cyclone wind, and storm surge) with the Global Human Settlement Layer map of resident population and built-up areas. In sum, the exposure of people and built-up areas increases as the extent in which human settlement grows in areas exposed to natural hazards (see Figure 6). The capacity to manage, curb, and reverse this interdependence can certainly be streamlined through planning.

This analysis, presented in in Human Planet Atlas 2017 (JRC, 2017) (superscript 12), show that exposure to natural hazards doubled in the last 40 years, both for built-up area and population. Earthquake is the hazard that accounts for the highest number of people potentially exposed. The number of people living in seismic areas has increased by 93% in 40 years (from 1.4 billion in 1975 to 2.7 billion in 2015). Flood, the most frequent natural disaster, potentially affects more people in Asia (76.9% of the global population exposed) and Africa (12.2%) than in other regions. The world population potentially exposed to flood is around 1 billion and is located in 155 countries as of 2015. Eleven Percent of the built-up area on Earth is potentially exposed to this hazard.

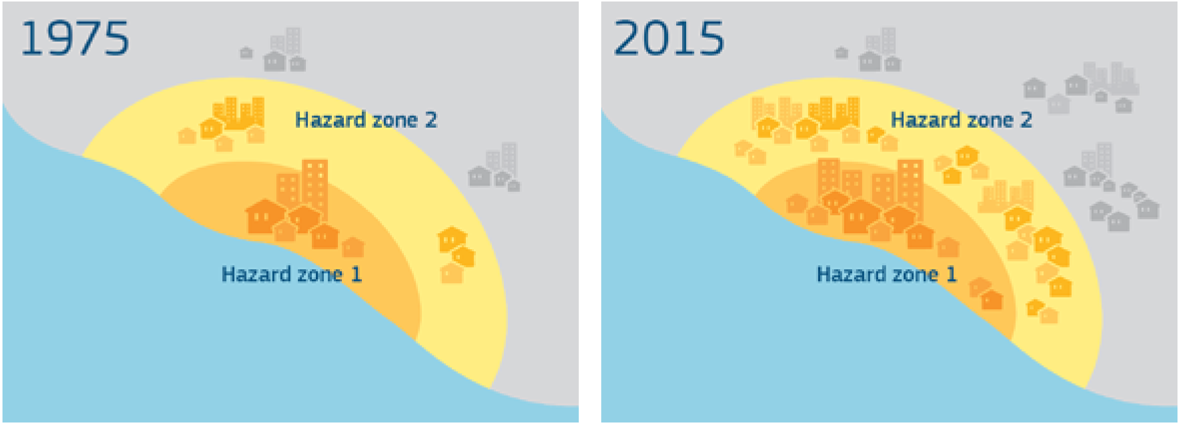


FIGURE 6: Hazard maps are produced using probabilistic methods based on different return periods. Hazard layers illustrate the probabilistic model and represent the probability that a hazardous event will occur in the future in a given geographical area. By observing the process of development taking place in human settlements exposed to the hazard with the GHSL it is possible to build a global understanding of the exposure of people and built-up areas to natural hazard

Tropical cyclone winds threaten 89 countries in the world and the population exposed to cyclones increased from 1 billion in 1975 up to 1.6 billion in 2015 (about 24% of the world population). In 2015, 640 million people were exposed to storm surge by extremely strong cyclone winds. By far, China is the country with the largest number of people potentially exposed to storm surge as a consequence of tropical cyclones. Fifty million Chinese people live in coastal areas included in the hazard area and this number increased by a factor of 1.5 in the last 40 years.

Tsunamis affect coastal areas in many regions, but dangerous areas are more concentrated in Asia. Japan has the highest amount of built-up surface exposed to tsunamis and its' population is 4 times more exposed than that of China, the second country most exposed. Sea level surge affects the countries across the tropical region and China has one of the largest increase of population over the last four decades (plus 200 million people from 1990 to 2015). According to our analysis, the global exposure of population and built-up surface to natural hazards increased in the last 40 years. Some hazards, due to their nature and characteristics, pose a threat to many people in different regions of the world.

Additional knowledge on the exposure of people and built-up areas to natural hazard, as a result of climate change, can be derived by observing how human settlements have developed in low lying coastal areas and river deltas exposed to sea level rise and floods. In this case, data sourced from space is vital. The Shuttle Radar Topographic Mission[14] made available high-resolution topographic data using interferometry. The resulting overlay between land elevations and human

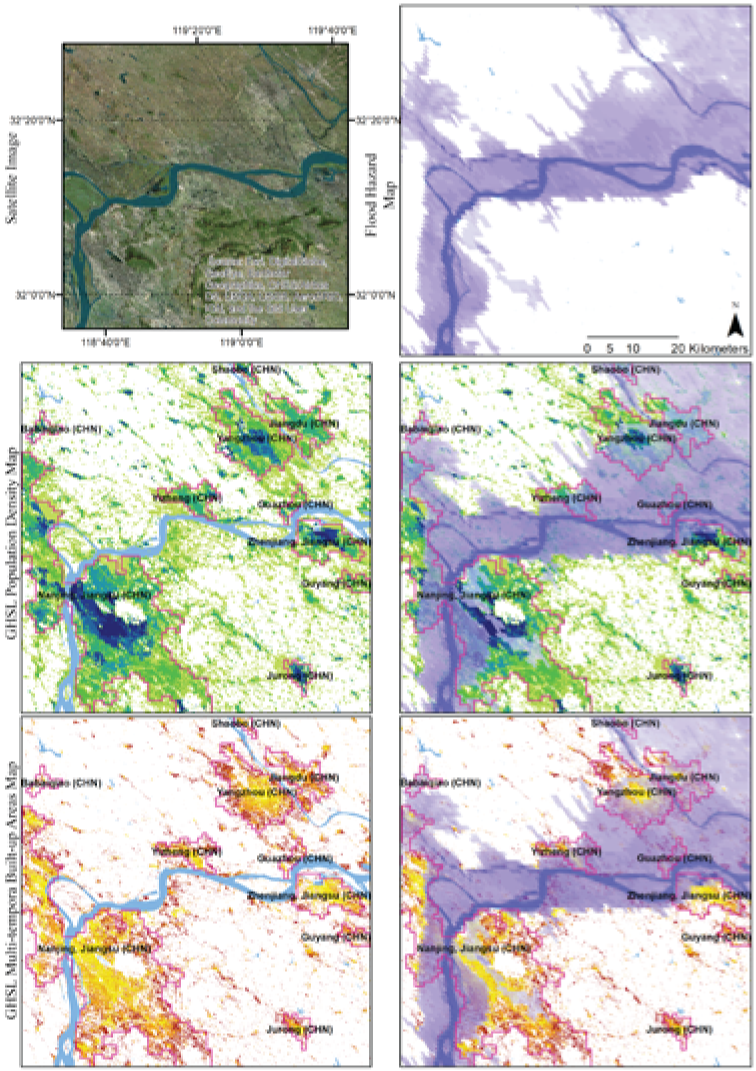


FIGURE 7: Combined map of population distribution and multi-temporal built-up areas expansion (1990-2015) and probabilistic flood map of Yangtze river in the Nanjing area (China). While almost all historical urban core (in yellow) were located in areas not exposed to potential floods, the urban expansion between 1990 and 2015 oftentimes took place in areas potentially exposed to floods (e.g. in the areas surrounding Yangzhou and Jiangdu). On the contrary, the most of the spatial expansion in Nanjing took place away from the floodplain

settlements map produced by GHSL helps quantifying the exposure of people and human settlements located in low elevated coastal areas, or on steep slopes[15]. Typically, the low elevation coastal areas (LECZ) fall in three geomorphological categories: the large river deltas, the naturally low lying coastal areas, and the low elevated small island states[16].

Valuable understanding on the dynamics of exposure of people to natural hazard can be drawn considering the frequency of relative increase in population exposed to natural hazards.

People exposure to cyclone winds has increased in 42 out of 46 countries, that to earthquake has increased in 123 of the 145 prone to; that to flood has increased in 137 of the 155 countries, in 71 of the 78 exposed to storm surge and in 80 of the 97 exposed to tsunamis. Overall, in only 68 countries the exposure of people has declined. In the vast majority (52 countries), the reduction in exposure has been moderate (between 0 and-25%). On the contrary, population exposed to the 5 selected natural hazards increased: up to 25% in 95 countries, between 25 and 50% in 117, and between 50 and 75% in 85, and it more than doubled in 100.

Figure 8, shows the relative change of exposed and not exposed and their geographical distribution. In 21 countries, people exposed to earthquakes more than doubled, especially in areas including Eastern, Southern and Central Africa and in Central and West Asia. In most countries (43) exposed population increased between 25% and 50%.

People exposed to tsunami increased by more than 200% in more than 10 countries, most of which are in Asia (e.g. Cambodia, and Bangladesh), Latin America and the Caribbean (including Venezuela and Brazil), and Africa.

People exposure to cyclone wind doubled in 7 countries most of which are in the Latin America and Caribbean region. Moderate exposed population increase (between 0% and +25%) took place in 12 countries across Asia, Latin America and the Caribbean and Africa. More substantial exposure increase (between +25 and +50%) occurred in other 12 countries, 5 of which are islands in Oceania (including Australia).

People exposure to storm surge is concentrated in classes of increase in the ranges 0% – 25% (11 cases), 25% – 50% (15 cases), 50% – 75% (12 cases), and 75% – 100% (13 cases). Most vibrant changes in exposed population (above +200%) took place in 6 countries of which 3 are in the Latin America and Caribbean region (Venezuela, El Salvador and Costa Rica).Of highest concern to policymakers and planners is comparison between increases in population in areas exposed to hazard and that in safer areas. From our analysis it emerges that population increase in exposed areas is often higher. In 35 of 46 countries exposed to cyclone wind, in 64 of 144 exposed to earthquakes, in 81 of 154 exposed to floods, in 54 of 78 exposed to storm surge and in 59 of 97 exposed to tsunamis, relative population growth has been faster in exposed areas compared to not exposed human settlements. These trajectories may imply unsustainable patterns of development as settlements and population grow in non-optimal locations.

Population in areas at sea level or below[17],in the 7 countries with the highest number of people settled in this class (China, the Netherlands, Egypt, Japan, India, Iran and Vietnam), has increased from 14 million people in 1975 to more than 35 million in 2015. This growth trajectory is mirrored at the global level, where population at sea level or below has almost doubled, from 38.5 million people in 1975 to 73.2 million in 2015. The Netherlands hosts the highest percentage of total population in low elevated coastal zones. There, as of 2015, more people living in areas

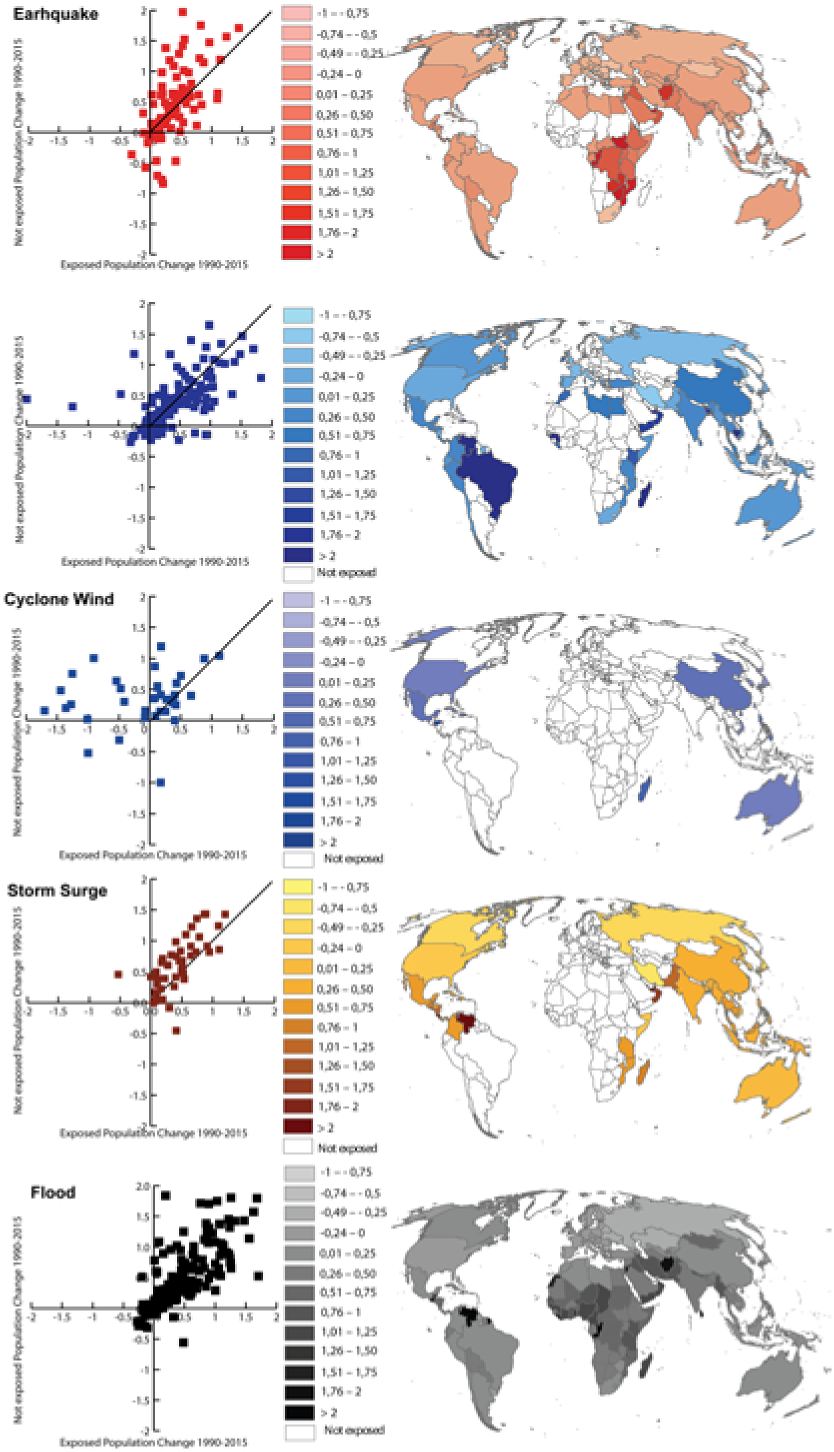
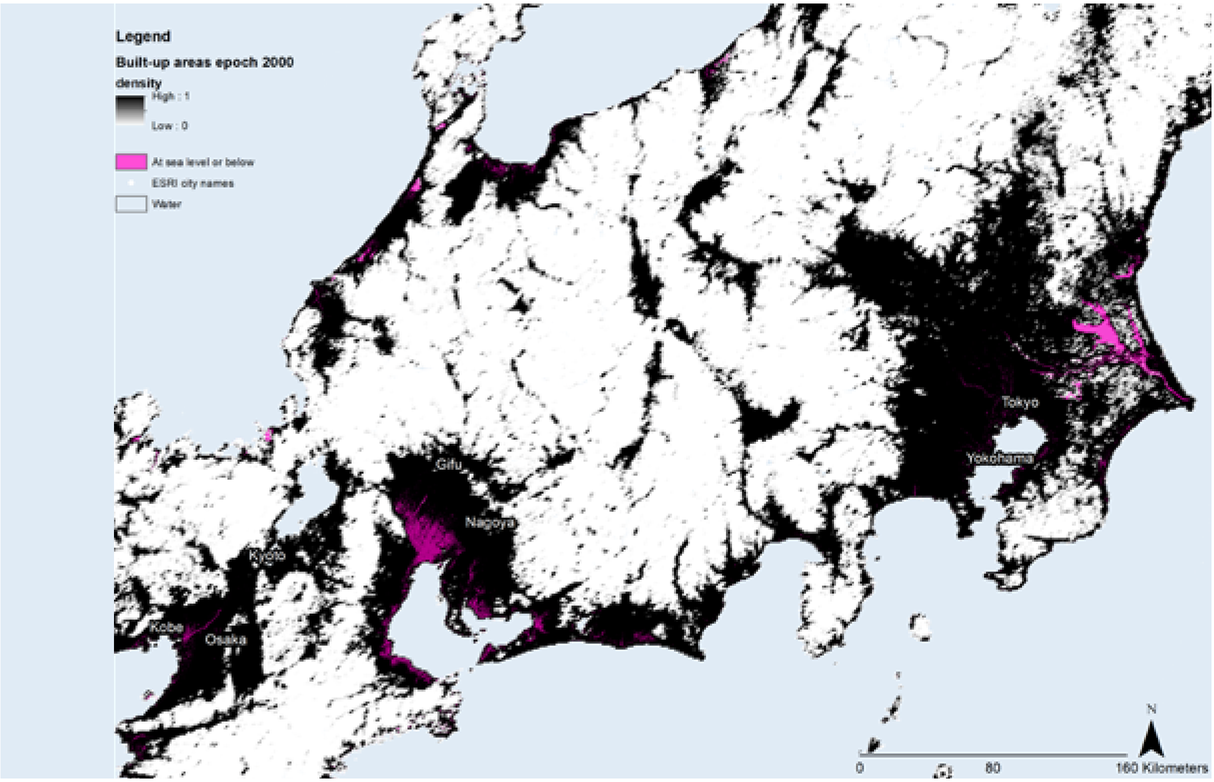


FIGURE 8: Change of exposed and not exposed and geographical distribution between 1990 and 2015 per natural hazard typology

lower than sea level than those living in high elevated areas. This figure of exposed population has increased from nearly 3 million people in 1975 to over 5 million in 2015. However, this information derived from the abstraction of settlement characteristics derived from satellites will have to be compared with the statistics generated by countries using more precise instruments to produce final assessments.

The aim here is not to provide a final figure of population or built up area exposed in a given geographical area of the world but rather to show the process used to derive these estimates, make transparent the datasets used in the analysis with the intent to promote reflection about ways in which settlements are planned, built and made resilient. Future comparison and validation will have to consider improvements of elevation data, precision, and the scale of the data collection protocol (i.e. built-up area detection from remote sensing sources and better census data for finer spatial disaggregation).

FIGURE 9: Delineation of large built-up areas in Honshu Island (Japan) in the epoch 2000 (1km grid resolution representing the density of built-up areas, ranging 0 not built to 1 fully built). The image highlights the extensive built-up areas along the south coastal areas corresponding to the megacity of Tokyo and Osaka and the city of Nagoya (hosting almost 8 million people) and the SRTM estimated elevation of coastal areas. Considering only Tokyo, Osaka and Nagoya, more than 3.2 million people are settled in coastal areas at sea level or below

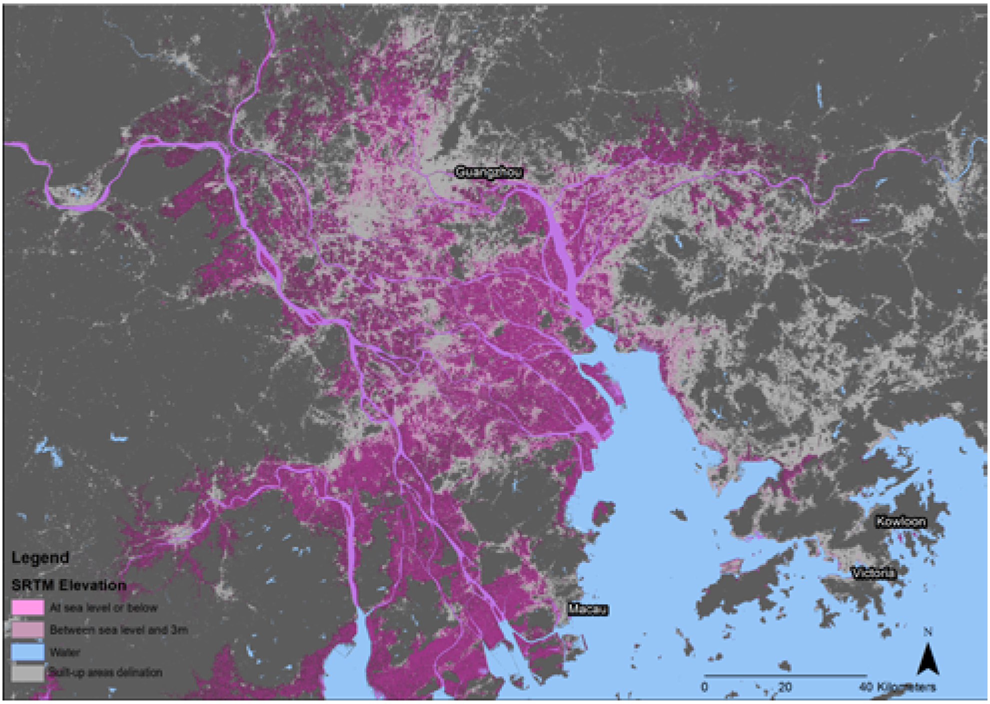


At local level, in urban centres like Guangzhou (see Figure 10) and Saint Petersburg, the population at sea level or below increased by millions in last 40 years (5 plus million in Guangzhou, and 1 plus million in Saint Petersburg). In several urban centres across the Netherlands, China, Egypt, Japan, and the United States of America more than 50% of the population is settled in areas at sea level or below, thus potentially exposed to sea level rise, floods, and other effects of climate change.

RESILIENCE THINKING WITH THE INTEGRATION OF PLANNING SUPPORT SYSTEMS

Our analysis shows that the human presence on Earth is threatened by natural hazards. GHSL information on built-up areas derived from Landsat imagery was not capable (due to its decametric resolution) to delineate the internal morphology of built-up areas, nor local measures to improve the resilience of settlements. However, it is capable to delineate an abstraction of the spatial change of settlements over time and to model the resident population. The dynamics of human settlements development in areas exposed to natural hazards sheds lights and warns habitat professionals about the importance of swarm planning, risk informed decision making, and resilience thinking for planning[18]. Aside this

FIGURE 10: Overlay between SRTM elevation map (elevation between below sea level and up to 3m) and the GHSL BUILT map. A substantial amount of built-up areas lay in low elevated coastal areas prone to sea level rise or flooding. Population accounted at sea level or below in Guangzhou increased by 3.5 millions since 1990



surveillance and retrospective analysis of human settlements development perspective, information on hazards can be further injected in the planning process, not just for statutory compliance, but also for a deeper integration with planning support systems helping practitioners, decision makers, and other planners to manage the complexity of a data rich environment [19].

INTEGRATING REMOTE SENSING AND PLANNING FOR MORE RESILIENT HUMAN SETTLEMENTS

The deployment of remote sensing technology to source information for intelligence and surveillance purposes has also evolved to scientific use to source new information. The scientific and civil use of remotely sensed information for societal benefits has allowed substantial advances in the understanding of how humans are interacting and modifying the planet Earth. The Group on Earth Observation (GEO)[20], strives to promote a new generation of knowledge production with Earth Observation derived information. GEO has a specific stream of action dedicated to human settlements (the GEO Human Planet Initiative[21]) that aspires to support evidence-based assessment of the human presence on earth. Information coming from these highly specialised and cutting-edge technology domains already provides information of vital importance to planning. The disciplines seem much closer in a supply-demand logic than in an actual scientific and policymaking interface.

With the EO community producing salient information at a fast rhythm, researchers and stakeholders from thematic disciplines have the opportunity to make use of this extraordinary wealth of information to produce new knowledge for their disciplines. In the planning domain, Earth Observation and remote sensing information can support a new generation of surveying and retrospective analytics. To advance in this we should strive to promote a class of planning professionals eager to produce this knowledge to inform policymaking and to enact spatial development measures.

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NOTEWORTHY CITY AND REGIONAL PLANS

↑↑ TOC

PROGRESS REPORT FROM WUHAN
PLANNING A NEW ECO-CITY AND A REGIONAL PARK

SONG JIE, CAO YUJIE, KANG JINGJING, TONG DANDAN

FIGURE 1: Yellow Crane Tower, the landmark of Wuhan City

This article describes two large scale projects which are part of the on-going effort to implement the master plan for the Chinese megacity of Wuhan. According to an article in the ISOCARP Review 7[1], the Wuhan Master Plan "... has advanced the idea of building an eco-system covering its administrative boundary characterized by 'two axes, two rings, six wedges and multiple corridors'".

The first section of this article describes the plan for new center within Wuhan designed to demonstrate sustainable development. At the end of 2015, the planning of the Sino-French Eco-City made its debut at the UN Climate Change Conference in Paris as a collaborative response from developed and developing countries to addressing global climate and environmental challenges. The Eco-City was to embody the philosophy of green, low-carbon development, industry-city integration, and stand as an international model for the practice of ecological civilization. The Sino-French Wuhan Ecological Demonstration City is emerging on the horizon as a more sustainable city of the future.

The second section records the development of a major park and recreation area which celebrates the Green and Water environment of the city.

INTRODUCTION

Wuhan, abbreviated as "Han", otherwise referred to as "Jiangcheng", is in central China and a core city in the Yangtze River Economic Belt. In addition to being the provincial capital of Hubei, it also is an important industrial base, a science and education center. Wuhan is called the "Gateway to Nine Provinces", acknowledging its status as the largest hub for land, sea, and air transportation in China, and a major transportation hub at the middle reaches of the Yangtze River. The catchment area of its high-speed rail network covers more than half of all Chinese territory, and its 55 international and regional air routes make it the only city in Central China with direct flights to four continents in the world.

The Yangtze River, the third longest river in the world, and its largest branch, the Han River, run through the center of the city and divide the central part of Wuhan into three parts, known as the three towns (Wuchang, Hankou, and Hanyang). With rivers and lakes interwoven throughout the entire city, water accounts for a quarter of the total area, giving Wuhan a unique ecological environment at the riverfront and lakeside areas.

WUHAN SINO-FRENCH ECOLOGICAL DEMONSTRATION CITY

The Sino-French Wuhan Ecological Demonstration City (hereinafter referred to as Sino-French Eco-City or the SFED) is in the Caidian District of Wuhan Municipality, close to the center of Wuhan City. With an area of approximately 39 km^2, the site is located amidst a network of water bodies include the Han River, Houguan Lake, the Shi River and the Gaoluo River. Ma'an and Linzhang Mountains frame the southern part of the site. More than 2,000 years ago, this unique natural setting inspired a musician to compose music which celebrated this location. But only a wood cutter admired and truly understood his music, so that these two became friends, an episode behind the story of Zhiyin[2]. Today the site contains the tomb garden remembering these individuals. which describes 'Bosom friends and the music of mountain and water'. This historic image inspired the international collaboration to designed the SFED at this site.

In March 2014, Chinese President Xi Jinping and (then) French President Hollande attended the signing of the Letter of Intent for the development of a Sino-French Ecological Demonstration City within the megacity of Wuhan. The project was to be a cooperation project to showcase sustainable development and to be jointly launched by the related ministries and commissions of the two countries. The project remains one of the most influential eco-city projects established by the Chinese government in collaboration with a foreign partner. Today the SDED is both an "encounter" of science and culture between China and France, and an

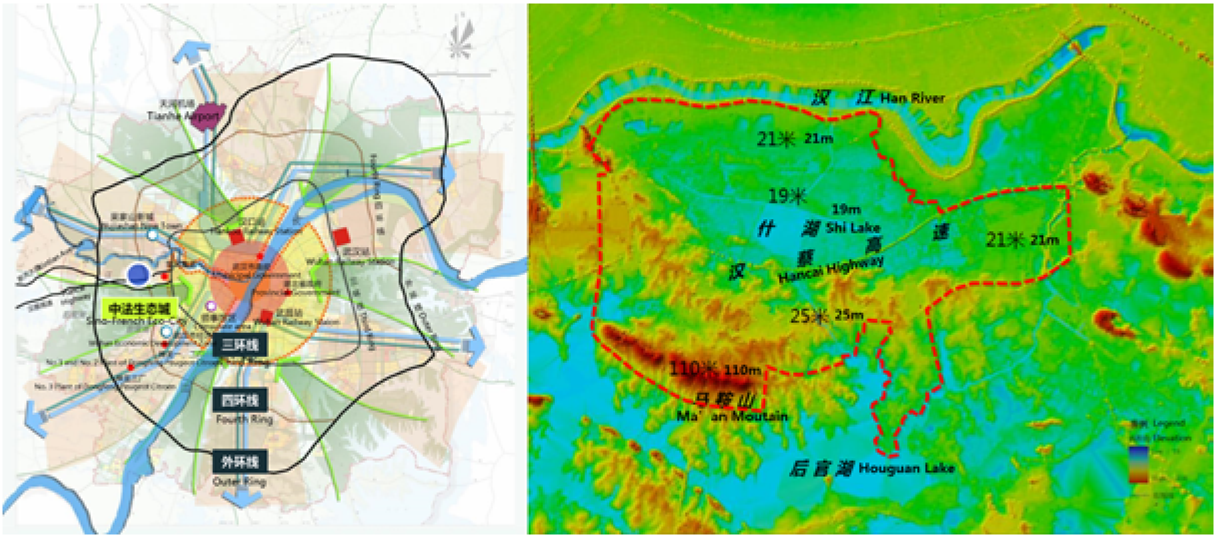


FIGURE 2: ↑ Location and boundary of the project site
FIGURE 3: ↓ The story of Zhiyin: bosom friends and the music of mountain and water

"encounter" of city, nature and people. This project also represents a practice and exploration of sincerity by two responsible major countries in solving global climate and environmental problems.

The objectives for the SFED were based on strategic analysis of other similar case studies at the international, national, and municipal scale. This study identified the following benchmark concepts: a demonstration area mitigating environmental problems in a sustainable way using technology suitable for use in developing countries; a model of a livable new city which prioritizes ecological and green development; a high quality growth center based on knowledge-focused employment with international visibility and appeal; and finally, a platform for technological cooperation and cultural exchange between China and France.

Three econometric and mathematics models were used to determine the ecological carrying capacity, the water security capacity, the population size, and the land use footprint of the development.

Using quantitative analysis methods, such as econometric, statistical and mathematics methods, the comparison to other similar projects provided some broad scale planning parameters. It suggested that the total 2030 GDP of the Eco-City would range from 397 to 485 billion yuan, the city would have an industrial composition ratio of 2:25:73[3], and the number of jobs created estimated at 118,000 to 144,000. The total planned population was estimated to range from 177,000 to 220,000 people.

Next, the theoretical program for the SFED was fitted to the land. First, the ecological carrying capacity for the entire Caidian District was determined using methods such as the estimation of the first net productivity of natural vegetation, an ecological footprint analysis, and the carbon and oxygen balance. This study showed that if population of the Eco-City reaches 200,000 people, then a minimum land use area of 17.4 km^2 was required.

Next the study team calculated the amount of drainage and water storage in the Eco-City area using the 100-year return standard. Then the comprehensive runoff coefficient of the area was identified and applied to various type of land uses. This study determined that a maximum site of 22.5 km^2 was required to ensure safe drainage.

Based on the combined use of the three methods above, the study team forecast the population of the SFED to be 200,000 people; the number of jobs to be 124,000; and, determined that 17 km^2 land area was required to accommodate SFED development by 2030.

The ecological index system applied to the SFED takes root in local conditions and was tailored to the actual conditions of development. It embodied the five

TABLE 1: Index System for the planning of the Sino-French Wuhan Ecological Demonstration City (2016-2030)

CATEGORY		ITEM		2030 VALUE	TYPE OF REGULATION	NOTE
City of industrial innovation	Economy	1. Ratio of tertiary industry (%)		≥70	Guidance	Wuhan: 50 Paris, France: 86.5, Lille, France: 76.5
	Science and tech-nology	2. Full-time Equivalent (persons) of R&D sci-entists or engineers in per 10,000 labors		100	Guidance	China-Singapore Tianjin Eco-City: 50, Japan: 104.7, France: 98.8, Germany: 84.2
		3. Average bandwidth home internet (Gbps)		≥1	Guidance	Wuhan "Thirteenth Five-Year Plan" outline: 100M home broadband, France's "Ultra-high Speed Internet Plan": 1G Home Broadband in French Metropolis in 2022
City of coordinated development	Society	4. Employment and Housing Balance Index		≥60	Guidance	China-Singapore Tianjin Eco-city: ≥50, Sino-Swiss Wuxi Low-carbon Eco-city: ≥30
		5. Coverage of free recreational and sports facilities (%) in residential areas within a 500-meter walking distance		100	Control	China-Singapore Tianjin Eco-city: 100
Low-carbon and environ-menta lly friendly city	Land	6. Per capita ecological land area (m2/person)		≥130	Control	By the Eco-City Plan
	Water	Water resource preservation	7. Water consumption per unit of GDP (tons per 10,000 yuan)	≤8	Control	Shenzhen: 12.1, Beijing: 17.58, Worldwide: 50
			8. Utilization of Re-claimed Water (%)	≥30	Control	National Ecological Gar-den City Standard: ≥30, Technical Index System of Green Ecological Urban Demonstration Areas of Hubei (Trial): ≥20
			9. Total Annual runoff control (%)	≥85	Control	Technical Guides for Sponge City Construc-tion - Development of Low Impact Rainwater System: ≥70, Beijing Economic and Technological Develop-ment Zone: 85, Shanghai Sponge City Demonstra-tion Area: ≥80
		Good water en-vironment	10. Urban sewage treat-ment rate (%)	100	Control	Sino-Swiss Wuxi Low-carbon Eco-city: 100

			11. Quality of Surface Water Environment (Classification)	≥	Control	Sino-Singapore Tianjin Eco-city: Quality Standard for Surface Water Environment IV
	Energy	Energy preservation	12. Energy consumption per unit of GDP (tons of standard coal per ten thousand yuan)	≤0.21	Control	Sino-Singapore Tianjin Eco-city: ≤ 0.3 (2020), Guangming New District, Shenzhen: ≤ 0.5
		Use of renewable energy	13. Renewable energy utilization (%)	≥20	Control	Sino-Singapore Tianjin Eco-city: ≥20
	Waste	Waste and emission control	14. Per capita daily output of waste (kg/person*day)	≤0.8	Control	Sino-Swiss Wuxi Low-carbon Eco-city: ≤0.8
		Waste Recycling	15. Ratio of Waste Recycling (%)	≥60	Control	Sino-Singapore Tianjin Eco-city: ≥60%
	Transport	16. Density of road network for slow-moving (km/km2)		≥15	Control	By the Eco-City Plan
		17. Accessibility of public transit facilities (m)		Coverage of bus stations at a 300meter service radius: ≥ 70%, Coverage of bus stations at a 500meter service radius: 100%	Control	Guangming New District, Shenzhen: Coverage of bus stations at a 300-meter service radius ≥ 70%; Chanba New District, Xi'an: Coverage of bus stations at a 300-meter service radius ≥ 50%, Coverage of bus stations at a 500-meter service radius 70%
		18. Green Travel Rate		≥90	Guidance	Sino-Singapore Tianjin Eco-city: ≥90 (2020), Sino-Swiss Wuxi Low-Carbon Eco-city: ≥80
City for Sino-French cooperation	Culture	19. Cultural integration and coordination		To meet standards set through specific research on cultural aspects of the Eco-City	Guidance	By the Eco-City Plan
City of harmony and sharing	Natural environment	20. Proportion of natural wetlands and water system (%) ≥ 18%		≥18%, and to ensure that the proportion is not reduced	Control	By the Eco-City Plan

	21. Ratio of local plants	≥0.7	Control	National Ecological Garden City Standard: 0.7
Built-up environment	22. Green-space rate in built-up area (%)	≥42	Control	National Ecological Garden City Standard: ≥38, Sino-Swiss Wuxi Low-Carbon Eco-city: ≥42
Building	23. Green building ratio (%)	1-star: 100, 2-star: ≥50, 3-star: ≥10, large-scale public buildings: Dual certification of China's 3-star and French HQE	Control	Comparative study of green building evaluation standards in different countries, focusing on China's Green Building Evaluation Standards and the French HQE standards
Air	24. Number of days when air quality is better than or equal to level 2 (days/year)	≥310	Control	National Ecological Garden City Standard: ≥300, Sino-Singapore Tianjin Ecocity: ≥310, 2016 Central Government Work Report: "The ratio of days with good air quality in cities at prefecture level or above exceeds 80%": ≥292

keywords of "innovation, coordination, green, openness, and sharing" and consisted of 24 unique (see Table 1) indicators chosen to be symmetric with of the characteristics of Wuhan City and the needs of the Sino-French Eco-City. The values for these indicators were set considering five different dimensions: references to relevant ecological indicators at home and abroad; codes and standards for urban and rural planning; references to similar eco-city practices; actual conditions of Wuhan City; and the research finding of both the Chinese and French teams on specific topics. The key indicators are expected to guide the development of standards and set the benchmarks for model eco-city practice in China.

From the perspective of regional integration, the study team used ENVI[4], ArcGIS analysis and field surveys to produce a detailed inventory and analysis of the ecological elements in the site. Further, by overlaying the ecological elements, they used both ecological suitability and construction suitability to guide spatial zoning and regulation (see Figure 4). Among the various zones created, the redline zone is the core area of biodiversity and ecological preservation. It includes the Han River, Shi Lake, Houguan Lake, and the Ma'an Mountain areas. A mixed-

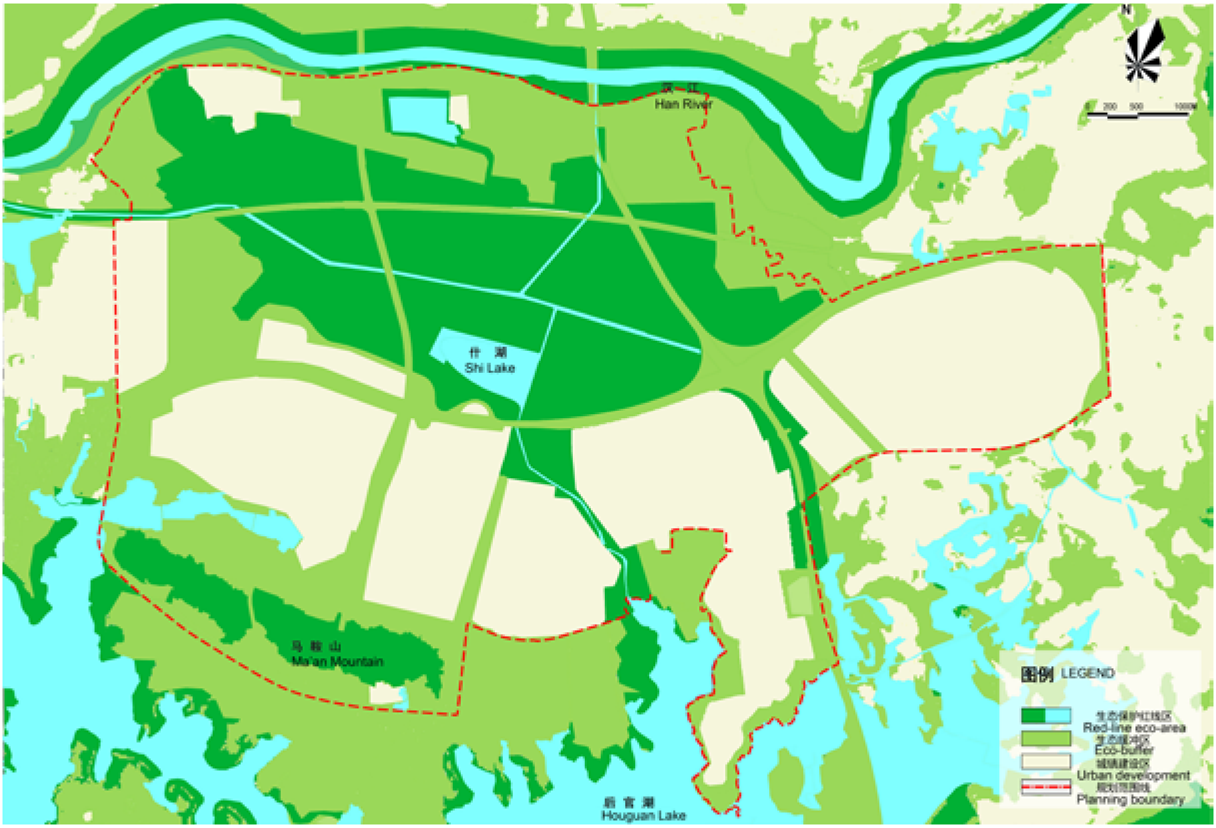


FIGURE 4: Spatial zoning for regulation

use buffer zone covers parts of the peripheries of the core area of biodiversity, the agricultural spaces, and the ecological corridor areas of the Han River and the Houguan Lake. Finally, the boundary for urban growth is drawn to exclude both the red-line zone for ecological preservation and the buffer zone.

The industrial composition of the Eco-City (see Figure 5) contains the following characteristics which take into consideration: its existing industrial base; regional industrial demand; support from France's advantageous industries; and, the requirements to building world-class ecological demonstration industries. The SFED’s primary industries will emphasizes ecological demonstration, such as the introduction of French urban vertical farms as part of a demonstration park for eco-agriculture tourism. The secondary industries emphasize high-tech demonstrations, such as the upgrading of existing manufacturing facilities to provide whole-vehicle manufacturing; R&D of new energy vehicles; and, energy saving and environmental protection industries. The tertiary industries were selected to complement the existing automotive and logistics industries by prioritizing the development of support functions, such as R&D, after-sale, and shared service

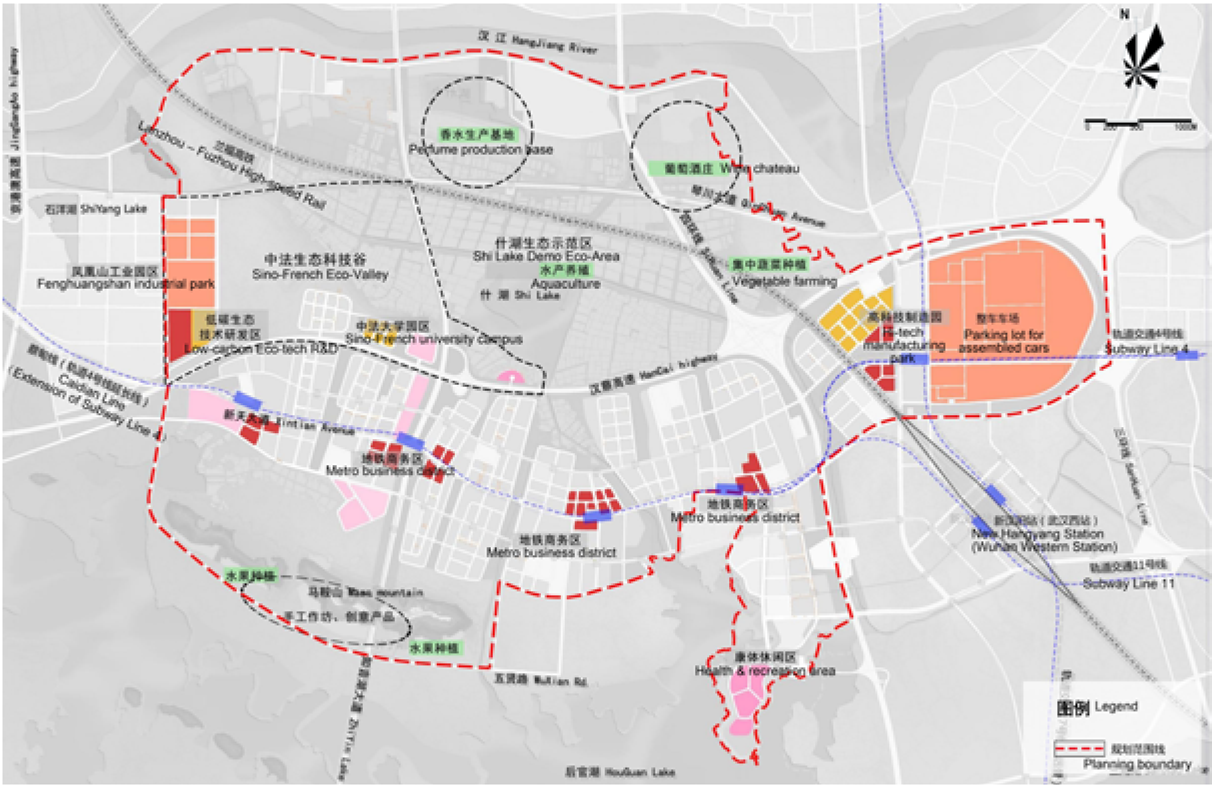


FIGURE 5: Layout of industrial land use

centers. Emphasized also are innovative and cultural industries such as those in the Sino-French Science and Technology Valley, a Sino-French art and cultural communication and training center, businesses related to the international health industry, and a demonstration center for innovation and development of urban agriculture.

The land use plan (see Figure 6) reflects the following concepts. First, the existing large-scale industrial lands, recently built large-scale residential areas, and rural settlements around Ma'an are preserved. Second, a certain amount of land for R&D was reserved for the Sino-French Science and Technology Valley. Third, an ecosystem of green spaces intertwined with urban development lands is proposed (see Figure 7). Fourth, combining the TOD (transit oriented development) model with the French experiences in mixed land use, the plan takes an innovative approach by defining high, medium, and low mixed-use land in the Eco-City.

The planning of the overall road and transportation network advocates a "bus-based, ecology highlighted, and scenery-integrated" approach embodied in a network structure with "high density roads and small blocks". The system is based on the framework of the existing road network, with arterial and secondary roads

FIGURE 6: ↑ Land use plan
FIGURE 7: ↓ Overall ecosystem diagram

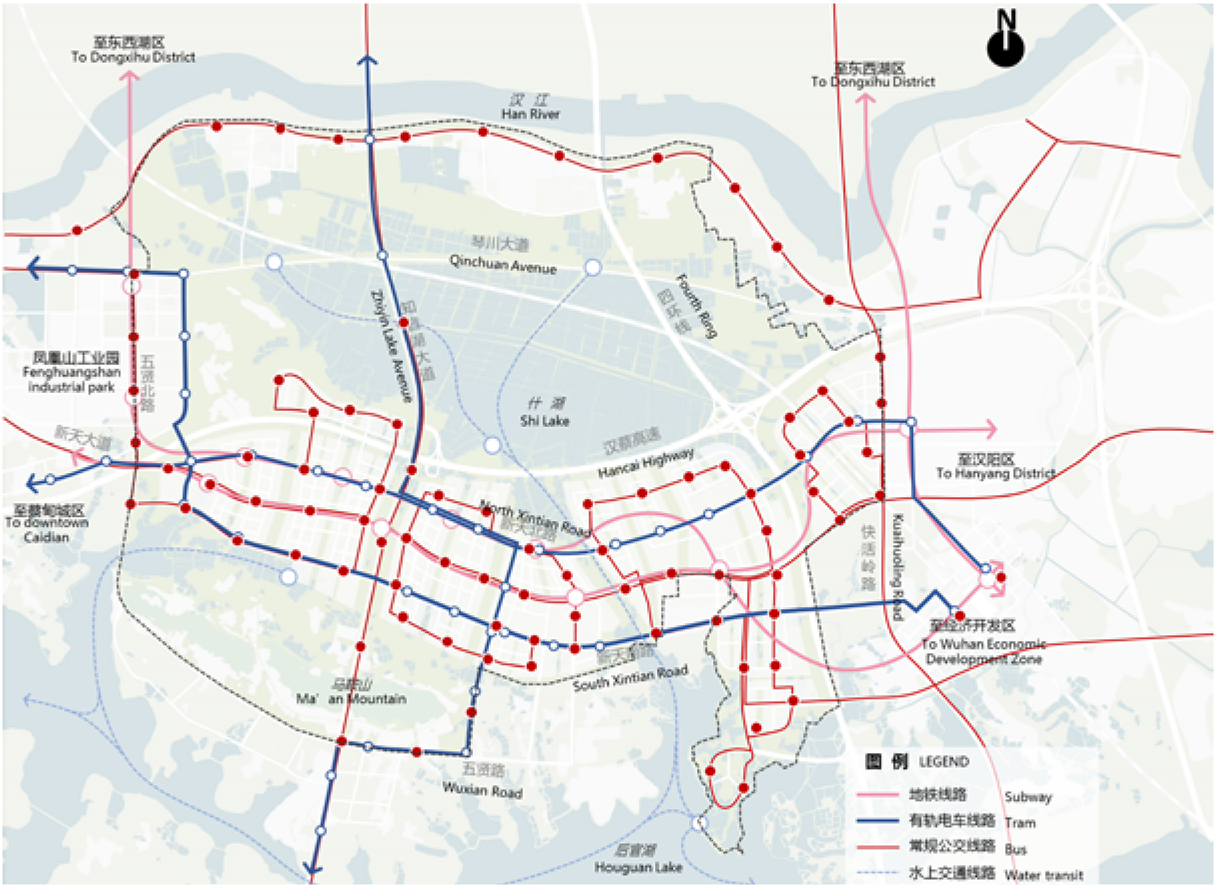


FIGURE 8: Planning of Public Transport System

optimized to promote bus transit and slow-moving traffic, in line with the idea of green mobility. Specifically, the bus transit system, with the new Hanyang Station at its core, is planned as a high-density public transit network with rail transit as the main body, BRT as the backbone, regular bus as the foundation, community buses as supplements, and water transit as the auxiliary (Figure 8).

The urban design of the Eco-City respects the existing topography and local features while practicing the design philosophy of “natural penetration and ecological sharing”. This design highlights the restoration of links between the rivers and lakes. It uses the Shi Lake as the central water body and achieves 100% collection of surface rainwater using natural drainage and storage of storm water at the intensity of a 50-year return period. The water network, consisting of a structure of "north and south rain gardens and multi-level ecological channels plus micro-circulation and infiltration passages", is also key to building an ecosystem linking the Shi Lake, Han River, Ma’an and Houguan Lake. At the same time, water drainage and storage facilities are integrated into the urban landscape, which realizes the sharing and combination of spaces for ecological functions and public activities, thus bringing people closer to nature.

A four-tier shared neighborhood system is proposed. It includes three types of residential cores: A City Center-Community Center; Residential Area Centers; and, Neighborhood Centers". Each core is located facilitate easy walking distances and to provide equal access to public services.

The integration of road and scenery is achieved by designing shared spaces along pedestrian routes between open blocks, such as pedestrian routes from subway stations to ecological green space or community centers; ground floor commercials space; and human-scale public spaces to guide pedestrian flows towards neighborhood gardens. Urban agriculture and roof gardens are also encouraged to facilitate the penetration of agricultural landscape into the neighborhood through "urban farms and green roofs." These designs demonstrate the fusion of ideas and technologies contributed by Chinese and French teams.

FIGURE 9: Overall urban design scheme

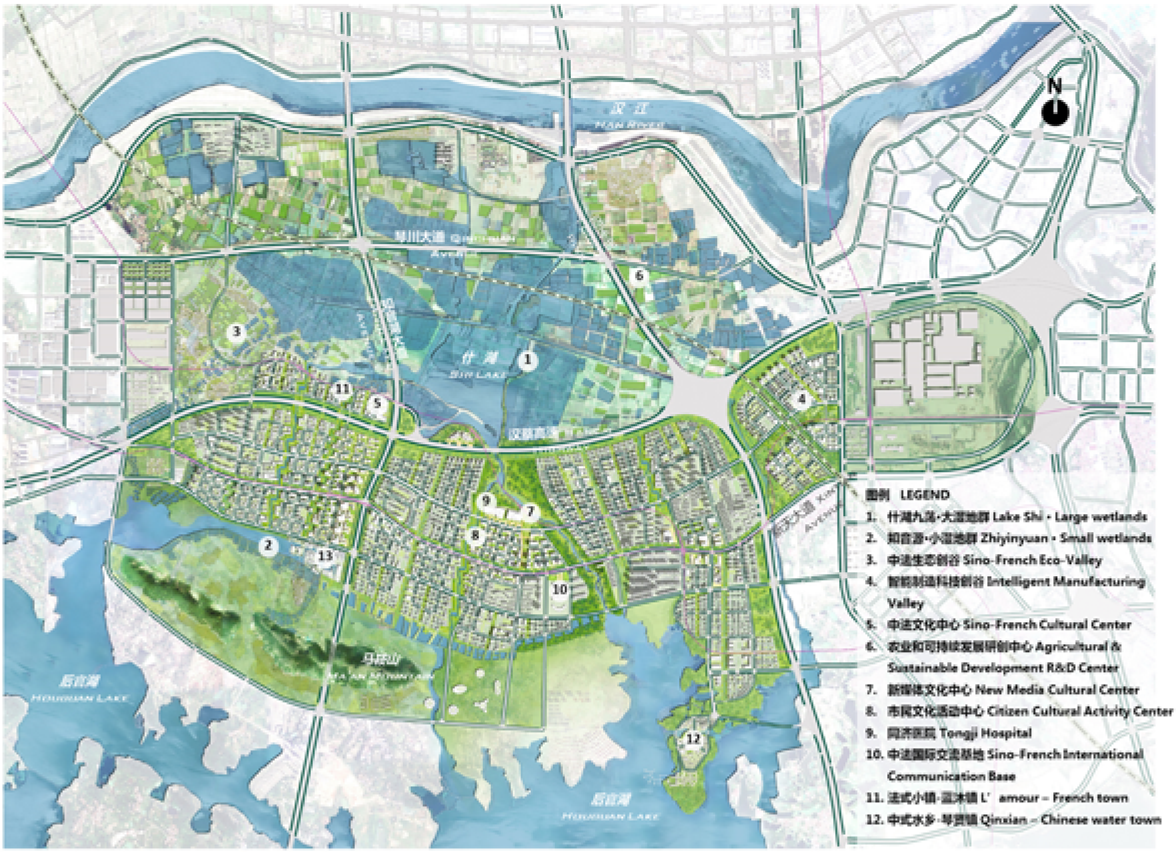


FIGURE 10: ↑ Aerial View of the Eco-City
FIGURE 11: ↓ Cluster of micro-wetlands at the Zhiyinyuan area

The Sino-French Eco-City establishes a model of circular economy, which allows collaboration and synergy between water circulation, garbage collection and disposal, energy use, and urban agriculture.

The water circulation system features water supply monitoring and the combination of engineered treatment and natural remediation of sewage, under the control of the VISIO center, which monitors urban floods in real time. Rain and waste water are treated by sewage plants before being recycled for agricultural, industrial and municipal uses. Other treated water sources are remediated by artificial wetlands before discharging. Energy conversion points for waste water are established to recover energy for heating or cooling of buildings. By integrating the drainage system of rain gardens, multi-level ecological channels, micro-circulation, and infiltration passages with recreational spaces, the capacity to control urban flooding and other drainage problems is improved. The comprehensive management of urban water recycling reduces the consumption of tap water by 40%, the utilization of recycled water is raised by over 30%, and the cost of water consumption for per unit of GDP is brought down to under 8 tons/10,000 yuan.

To facilitate garbage collection and treatment the system uses vacuum pipelines, intelligent containers, and WIFI-connected trash cans (which rewards garbage collection to improve collection at the source). Low-carbon transportation methods are adopted. Upon reaching the sorting center, certain sorted materials are reuse or recycled with an overall recycling rate of biological waste at over 70%.

In terms of energy use, the application of bio-climate methods helps optimize the urban spatial form and reduce the heat island effect. The development of “zero-energy” buildings promote the intensive use of energy. Using a “distributed”, yet “networked” model, solar energy, waste water, waste gas, air thermal energy and industrial waste heat are comprehensively collected and utilized. Thermal energy is recovered by creating hot water loops in Shihu Lake and the underground water layers. The innovative use of internationally leading technologies, such as carbon wells and hydrogen storage batteries, helps to purify the air and to achieve a 70% coverage of energy demands by local energy sources, and a utilization rate of renewable energy sources exceeding 20%.

Modern agricultural areas are promoted on selected greenbelt in the SFED. This practice not only enriches urban spatial forms, but also reduces the negative impact of the existing agricultural activities on the environment. Various modes such as roof greenhouses, hydroponic greenhouses and vertical farms are used to overcome the constraints of urban climate. To reduce the impact on resources and the environment, relevant measures for circular development are taken, such as the control of erosion, retention of soil fertility, saving of water and energy resources.

In terms of smart cities, the Eco-City Smart Control and Management Center provides comprehensive and integrated control of smart transportation, smart resources, smart information, and smart environment, etc. Using performance evaluation and quantitative indicators, the integrated roadmap for implementation has been formulated for water, energy, and garbage regulations to ensure the materialization of ecological technologies.

The SFED is under development and phase one is planned for completion in 2013.

THE PRACTICE OF URBAN GREEN PUBLIC SPACE IMPROVEMENT – EAST LAKE GREENWAY PROJECT IN WUHAN CHINA

Urban public spaces play a vital role in sustainable urban life. They not only reflect the city's spiritual outlook and cultural connotation, but also help urban residents to communicate with each other, cooperate with each other, and actively and effectively participate in public activities. A good public space also satisfies the needs of vulnerable groups such as women and children.

BACKGROUND

In March 2012 the WPDI hosted an ISOCARP Urban Planning Advisory Team (UPAT) workshop to define development strategies and sustainable concepts for the Wuhan East Lake Scenic Area. The UPAT Team of eight ISOCARP members worked closely with planners and staff of the WPDI, the Wuhan Land Resources and Planning Bureau and the East Lake Management Office. The UPAT Team visited the East Lake Scenic Area in the period March 11 to 16, 2016 for an intensive week of fruitful discussions and debates. In its report, the ISOCARP UPAT Team[5] recognizes that the East Lake Scenic Area has the capacity to become an inspirational example of sustainable development in China's paramount "Lake City" which provides: 1. an enhanced visitor experience, based on ecotourism principles, that benefits both the people of the Wuhan area and those from wider afield, showcases the achievements of Wuhan, and matches the best available in other Chinese cities; 2. a cleaner and healthier lake environment, together with an enhanced landscape, wildlife and cultural heritage for the benefit of this and future generations; 3. improved accessibility to the Scenic Area coupled with better connectivity within its perimeter, especially by boat, bus and other low carbon means (like a network of Greenways); and, 4. enhanced economic and employment opportunities, including tourism and travel, research and development, arts and crafts and other sectors of the local economy.

In 2015, the United Nations released the "2030 Agenda for Sustainable Development". For the first time this agenda treated urbanization as a very important issue and set forth the target to build more inclusive cities and treat the improvement of public space as an important indicator of sustainable urbanization. In the same year, UN-Habitat also released a new "Global Public Space Toolkit" that provides global principles for local policies and practices of public space improvement.

In June 2016, UN-Habitat approved the Wuhan Land Use and Urban Spatial Planning Research Center (WLSP) to be its partner to promote the development of urban public spaces in China and to adopt the East Lake Greenway Project as the pilot project.

In June 27 to 28, 2016, UN-Habitat formed an expert group to hold a meeting in Wuhan to evaluate the East Lake Greenway project. International experts from UN-Habitat headquarters and Asia-Pacific regional offices, and Chinese experts from Beijing, Shanghai, and Hong Kong attended the meeting. The expert group conducted a field survey in East Lake of Wuhan and held discussions with the WLSP East Lake Greenway Project planning team.

The expert group fully agreed with the people-oriented planning method, affirmed the open, free-of-charge, non-profit, accessible and inclusive principles of the project, and announced that the Wuhan East Lake Greenway was formal-

FIGURE 12: Kick-off meeting for "Wuhan East Lake

FIGURE 13: East Lake Greenway Forum at the 3rd Greenway: UN-Habitat Demonstration Project United Nations Conference on Housing and for China's Urban Public Space Improvement" Sustainable Urban Development

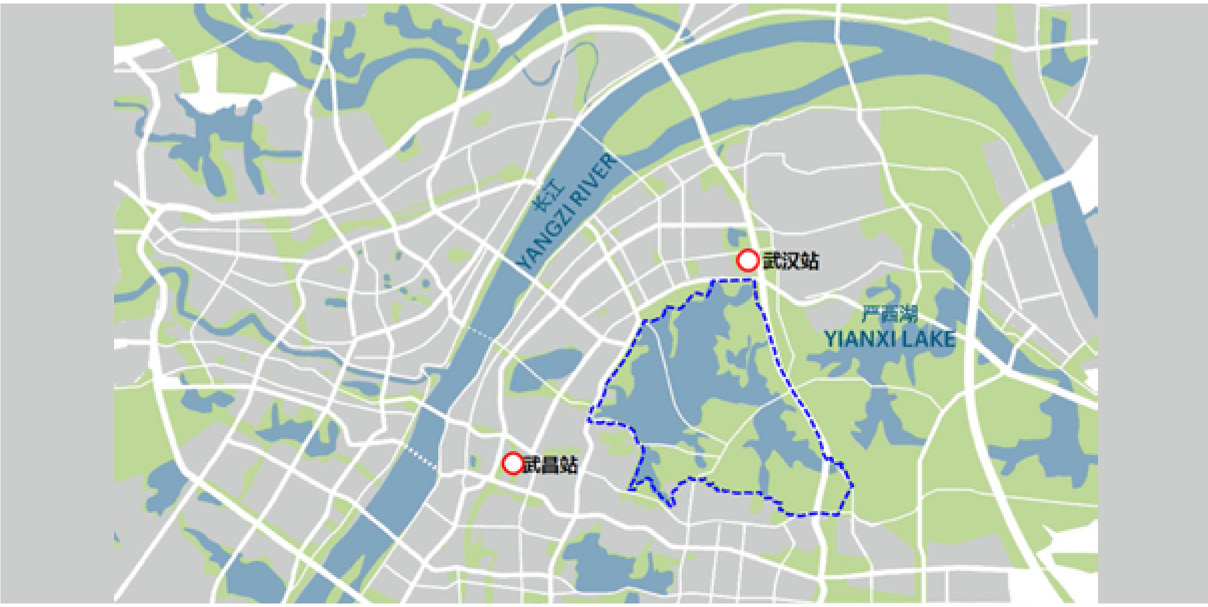
ly selected as the "UN-Habitat demonstration project for China's urban public space improvement". Moreover, the expert group believed that the city-level policy, strategy and legislation for the project should be implemented, after they were combined with the new international guidelines and the observations from the meeting. There also were suggestions about the continuation of cultural and historical elements, developing a sustainable business model and the formulation of an urban resilience strategy.

On October 17, 2016, the Wuhan East Lake Greenway Project was promoted to the world at the United Nations Conference on Housing and Sustainable Urban Development, as the first Chinese "UN-Habitat demonstration project for China's urban public space improvement".

ABOUT WUHAN EAST LAKE SCENIC AREA

Wuhan East Lake is in the area between the Second Ring Road and the Third Ring Road of Wuhan. It has a total area of approximately 62 km^2 of which 33 km^2 is water surfaces. It is the largest "city lake" in Asia and is a national-level scenic area. It currently has a total population of about 51,400. There are 40 colleges and universities with more than 500,000 teachers and students and 56 national and ministerial and provincial-level research institutes around East Lake. A total of 13 plant gardens, including plum and cherry gardens have been built in this scenic area, along with more than two million ornamental trees representing 250 varieties.

East Lake holds an irreplaceable position in Wuhan's spatial pattern of "One Lake and Two Rivers". The core characteristics of East Lake lie in the evolution of the city over thousands of years. It has a background of suburban ecology represented by "ten thousand mu of water, one-hundred-meter-long embankment



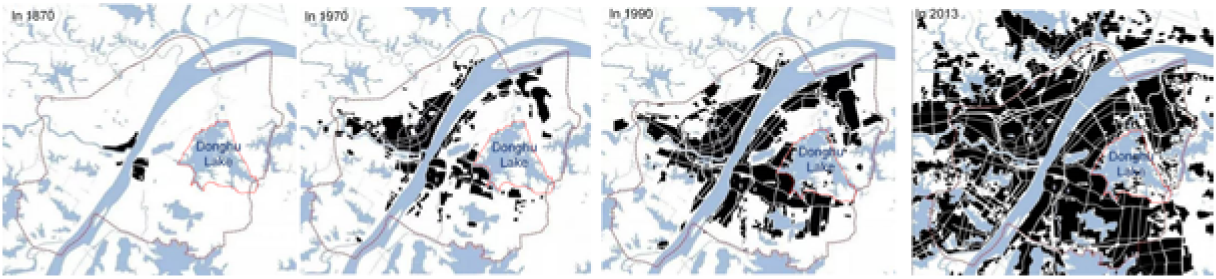


FIGURE 14: ↑ East Lake location
FIGURE 15: ↓ East Lake and urban development history

and gardens with flowers of four season". The characteristic landscape pattern represents the concept of "half mountain and water and half city". The site contains unique human landscape resources, such as the Chu culture represented by Qu Yuan; the red culture represented by Mao Zedong; and the scholarship culture represented by college city.

Despite its good resources, a preliminary planning public survey reported multiple difficulties. It was hard for the public to reach multiple scenic areas in succession. Some high parks fees curtailed public access. It was hard to find accurate directions; there was a lack of activities and adequate service facilities; too many vehicles pose dangers to pedestrians; the water quality of East Lake was declining; and, local residents did not benefit from the ecological resources before 2015.

Therefore, Wuhan began to reflect that a city should not be a forest of reinforced concrete but should be a beautiful home in which the people and nature co-exist in harmony. In 2015, the Wuhan Municipal People's Government made it clear that it would focus on the construction of East Lake Greenway, hoping to provide citizens with more accessible, improved, ecological and inclusive public leisure space and improve the living standard of residents of the Greenway. In this context after considering the actual conditions and expectations of the public, the following objectives for construction of East Lake Greenway were identified: 1. link existing fragmented spaces where reasonably possible; 2. achieve equal sharing of spaces; 3. realize the connections with urban functions; 4. strengthen the vitality of current sites and landscapes; 6. reduce the interference of human activities in the natural areas; 7. meet the needs various users; and, 8. improve the existing unfriendly slow spaces.

As put forth in the New Urban Agenda[6], the key to achieving the goals of New Urban Agenda is to promote socially inclusive, comprehensive, connected, accessible, environmentally sustainable, and safe public spaces. The East Lake Greenway Project was planned around this goal.

Different from previous planning, a comprehensive online platform for public involvement was established to actively use the wisdom of the public. A first-of-its-kind on-line planning platform was established to allow the public to participate in the planning. This approach viewed the citizens as the major designers of the project and provided citizens with the means to participate in the planning. The online planning modular allowed the public to view and create project planning drawings. Then GIS and AHP technologies were used to analyze the background data and embody the ideas made by the public into the actual planning and design. The traditional methods of public involvement, including information posting, publicity, and on-site interviews were also used to solicit opinions and ideas from the public regardless of their occupation, educational background and qualification. In addition, on-site interviews were conducted with specific target groups such as riding enthusiasts, the elderly, the disabled, women and children, students and young artists, tourists, and residents to fully analyze the needs of these users. These actions greatly improved the public's enthusiasm for the project and, to a large extent, achieved the people-centered goal.

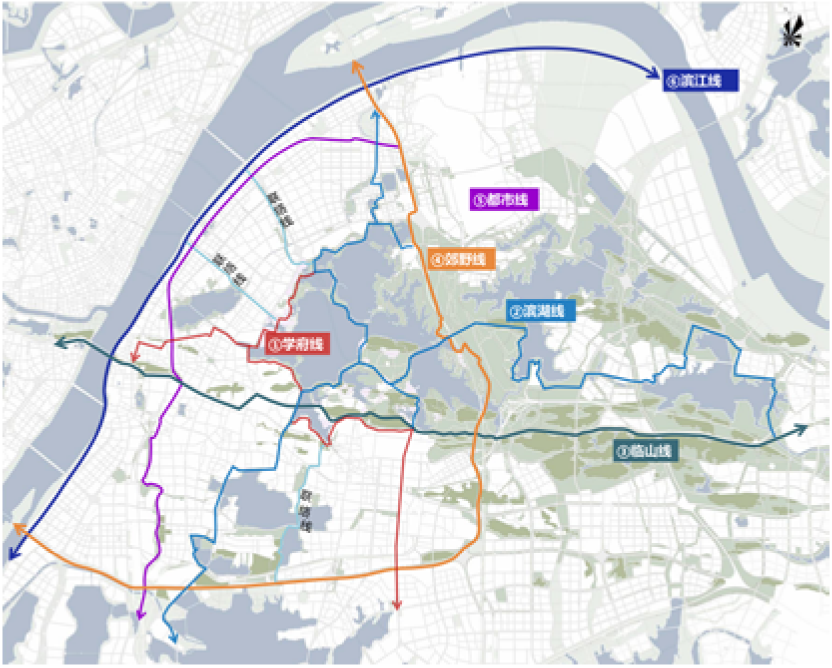
Meanwhile, these innovative methods of public involvement insured that the public's opinions were also used in the whole process, from consultation during the earlier stage of planning, to the selection of planned route, to the detailed design of the plan, and to implementation. The goal that the public directs the planning was achieved.

Other administrative changes were made. Immediately, scenic spots which previously charged an admission fee were opened to the public free of charge to achieve the goal of equal sharing of all public spaces. At the same time, park

FIGURE 16: Webpage of the public planning platform http://zg1.wpdi.cn/Default.aspx

programming was enhanced. With the provision of a theme greenway and event space, a variety of activity venues were started. These included the creation of a variety of activity venues, the implantation of various exercise activities, and, the organization of international cultural contests were implemented to allow the citizens to enjoy the public activity spaces as much as possible. The laboratories and sports fields of colleges and universities are also set to be open to the public, at certain times, to allow citizens to experience the study atmosphere of colleges and universities while experiencing the greenway, thus letting the colleges and universities get involved in the city.

A development framework connecting the functional zones of Wuhan to important colleges and universities, cultural features, lakes, mountains, suburbs, public centers, and other public spaces in the region was planned and will be established. Upon formation of the project, a 124 km long, motorized vehicles-free East Lake Greenway will be developed to motivate the vitality of the urban space to the largest extent. To ensured that the through-traffic will not interfere with the internal park traffic, visitor flows and facilities are seamless connected and enable users to enter into the Greenway conveniently. Hence, the goal of allowing citizens to enter the urban public space with ease is achieved.



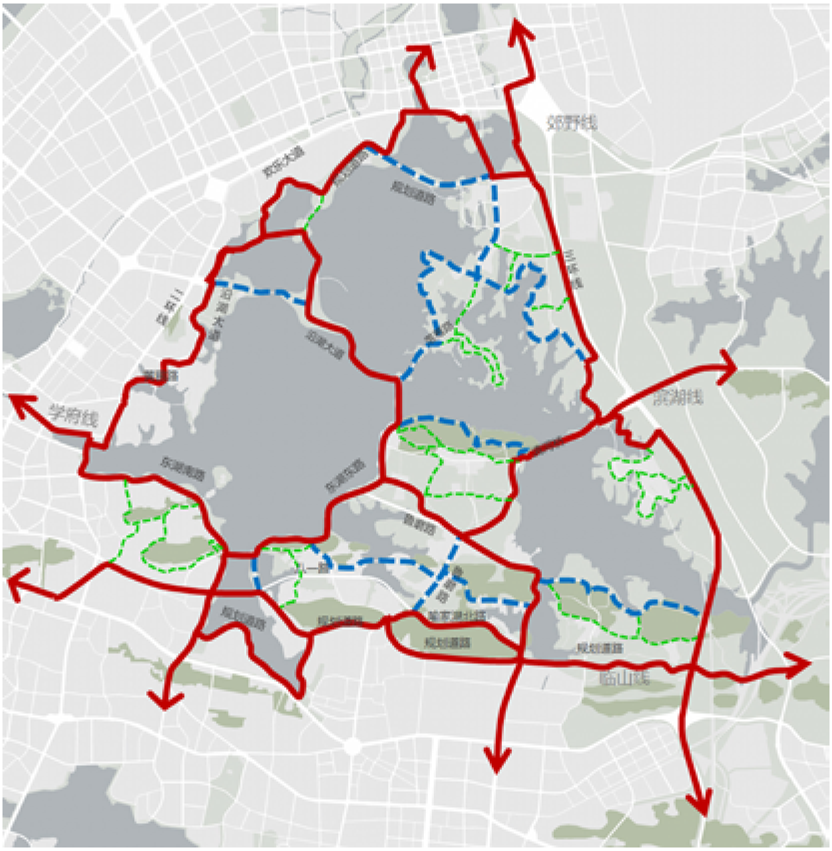


FIGURE 17: ↑ Regional greenway system
FIGURE 18: ↓ Planning for 124km long East planning Lake Greenway

In combination with the main entrances and exits of East Lake, a regional roadway was designed to assume the functions of service support, traffic access, and portal functions, and to achieve a positive interaction and integration of urban functions and public spaces.

At the same time, the plan called for the landscape features along East Lake to be integrated to create a variety of distinctive greenways, such as waterways, forest-roads, flower roads, night lanes and race tracks, where citizens and tourists can obtain different greenway experiences by walking through the lake and into the forest, wandering in the flowers, enjoying the night vision and running vigorously.

To recover the natural feel of the site, a series of activities have been carried out to improve the original ecological environment of East Lake, such as building ecological gentle slopes, recovering the ecological landform, protecting and recovering the vegetation along the greenway and implementing water system interconnection project.

Pedestrian, slow-moving, and low-carbon travel is advocated in the Park. The travel of motor vehicles in the scenic area will be reduced and carbon emission will be cut by returning some sections of the roadway system to slow traffic.

Greenway materials which satisfied strict standards were used to implement low impact development and minimize the impact on the natural environment. Roof greening and rainwater collection were adapted into green posthouses, where a natural ecosystem purification system was established.

The plan calls for animal habitats to be protected, and the biological diversity ensured by establishing animal pathways preserving the migration patterns of animals. These efforts thus achieve a harmonious co-existence between human and nature.

A sound ecological environment assessment system was advocated to further assess the environmental impacts of air, wastewater, noise and solid wastes, and to set up a dynamic assessment and early warning system. This enabled timely adjusts and the updating of management measures.

To meet the needs of the elderly people, the disabled, women, children, students, young artists, riding enthusiasts, and tourists, a rest station system of providing different service was set up, including those to guarantee safe facilities, toilets, rest facilities, and restaurants.

The living environment of East Lake residents was improved by providing ecological tourism employment opportunities. This stimulated sustainable economics in the scenic areas, thus promoting the overall development of the area.

The safety of people when using the greenway is ensured by returning the roadways to pedestrians and setting up safety facilities along bicycle paths.

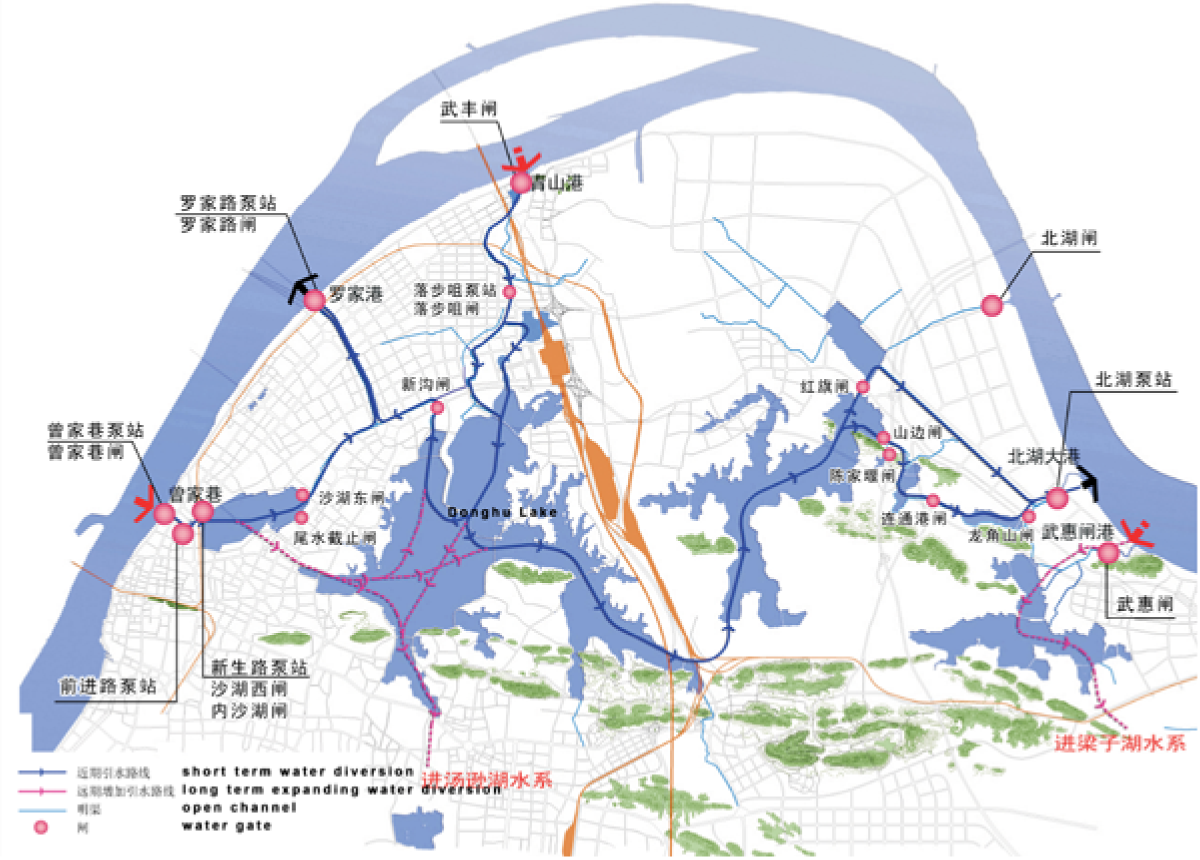


FIGURE 19: ↑ Water connection
FIGURE 20: ↓ Ecological renovation of planning vertical revetment

FIGURE 21: Intelligent security system planning

A series of safety measures such as real-time monitoring, alarm assistance and emergency response were provided by the establishment of an intelligent system.

The inheritance of Wuhan's Chu culture and Wuhan's local culture is reflected in the selection of plants and architectural style throughout the park. In addition, design consideration was given to college science and education resources by creating poetic, painting, and scholarly themed cultural landscapes and alumni cultural parks.

To continue the statutory planning and to provide guidance for the opening of large public space to the public, the graded and classified protection scope of the scenic area was defined by continuing the land use layout of the East Lake Master Plan. This ensured and guided the construction and maintenance of public open space via legislation.

A public management system, jointly managed by various governmental departments, the construction companies, and the operation companies was established to guarantee long-term improved public spaces and policy consistency. Its emphasis is that the plan should be implemented first, and then, in phases, further orderly construction should be accomplished.

BEFORE AFTER

FIGURE 22: Comparison between before and after Huzhong Road along the East Lake Greenway is renovated. Photos are made on the same spot, five years apart. Before the implementation of this project, the routes through the East Lake were sneak routes for taxis and busses. Now these routes are used by cyclists and pedestrians only

IMPLEMENTATION AND RESULTS TO DATE

Between the end of 2016 to the end of 2017, the first phase and second phases of the East Lake Greenway were been built, opened to the public and connected into a circle. This phase has a total length of 102 km. As of December 2017, the total number of visits to the East Lake Greenway was nearly 10 million. Today, the East Lake Greenway has gradually become an important venue for international competitions and civil activities. Participation and quality of the recreational experience in the East Lake Scenic Area has been significantly improve with events such as the Wuhan Marathon, the Xidesheng Cup Cycling Tournament and the Wuhan Water Marathon – all of which were held on the East Lake Greenway. As of December 2017, there have been over 700 events held on the East Lake Greenway by non-governmental organizations.

After the implementation of the East Lake Greenway project, the carbon emissions of the scenic spots have been greatly reduced, the water quality of East

BEFORE AFTER

FIGURE 23: Comparison between before and after the North Gate of Moshan Hill along the East Lake Greenway has been renovated

FIGURE 24: Map and Guide for East Lake Greenway

Lake has improved, and the ecological landform and the revetment were restored by banning the use of motorized vehicles on the four roads in the scenic area. These efforts have restored the ecological environment. These improvements also promoted free access to the core scenic spots and promoted the transformation of the villages in the scenic area, greatly improved the living quality of local residents. In addition, local residents have been provided with many employment opportunitie[7] during the construction and operation of the park.

ENDNOTES

1 See: Liu Qizhi, He Mei, Wang Yun, Planning the Ecological Spatial System of the Megacity of Wuhan. ISOCARP Review 7, 2007, pages 218 – 233.

2 The commonly used word Zhiyin is used to describe a soulmate or friend, but its literal meaning is actually "understanding the music." As with many Chinese expressions, Zhiyin has interesting historical origins. In the Spring and Autumn Period of China, there lived two people who shared a very special relationship: a famous Qin player named Boya, and a woodcutter named Zhong Ziqi. They shared nothing in common, but this: When Boya was playing the Qin to express the grandeur of the high mountain, Zhong would observe, "Wonderful! It's the mighty Mountain Tai." When Boya had thoughts of water infused in his playing, Zhong would say, "Wonderful! It's the fast-flowing water." Every time Boya would

play, Zhong Ziqi could understand the meaning behind the music. After Zhong died, Boya vowed to never play again because no one could understand his music as deeply as did Zhong Ziqi.

3 The ratio represents the relationship between agricultural, industrial and service jobs.

4 See: https://www.harris.com/solution/envi

5 See: https://isocarp.org/activities/upats/past-upats/2012-wuhan-china/ and https://isocarp.org/app/uploads/2014/05/Wuhan_UPAT_Report.pdf/

6 Released at United Nations Conference on Housing and Sustainable Urban Development (Habitat III Conference) in 2016

7 Of note, the project construction has caused some women affected by the park land acquisition to abandon farming and to work in the secondary and tertiary economic sectors. This has, to some extent, reduced the local gender division in the labor force.

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SUSTAINABLE NORTHERN URBANITY
AN EMERGING RESEARCH AGENDA

MATHIAS B. REINAR, AASE KRISTINE LUNDBERG,
AMSALE K. TEMESGEN, KJERSTI GRANÅS BARDAL,
BJARNE LINDELØV, TONE MAGNUSSEN,
INGRID BAY-LARSEN, BERIT SKORSTAD

FIGURE 1: A northern streetscape. PHOTO BY Espen Mortensen

INTRODUCTION

Cities are said to be the solution to many of the major societal issues reflected in the UN's sustainability goals, which emphasize cities as key to creating inclusive, safe, robust and sustainable communities (Parnell 2016). Supporting these goals, the Norwegian government's white paper on national territory (St. Meld. 18 2016-17) promotes sustainable, compact cities and strong districts. However, to achieve sustainable regional futures in the North, small and medium-sized cities must resolve challenges of demography, social exclusion, disconnection from the knowledge-based economy, and sprawl.

In addition, Northern cities will experience climate changes that will exceed other European regions. According to moderate scenarios from the Intergovernmental Panel on Climate Change, temperatures will increase by 1.7 to 3.1 °C by 2100. Sea level rise and altered access to marine and land resources are some other serious impacts that arctic urban societies may face in the future (Crepin et.al 2017).

FIGURE 2: Map of Barents Region.
SOURCE: http://www.barentscooperation.org/en/About/For-press-and-public-use

Today, more than 70 per cent of the roughly 5 million people in the Barents region live in cities (AMAP 2017). Urbanization, including the transformation to low carbon societies, is therefore a key dimension of sustainable development in the Northern region. Urban planning is seen as a key strategy for reducing climate gas emissions at a global scale[1].

The transformation to low carbon cities is a central issue for local and regional policy makers and city planners, but some regional characteristics make this transition difficult. First, Northern cities are relatively small. The biggest city in Northern Norway is Tromsø, with a population of around 70,000 people, followed by Bodø with 50,000 and Harstad with 25,000.

Second, low population growth, an aging population and the emigration of young people represent obstacles to economic performance and the quality of services. Yet Northern cities retain and attract their populations to a higher degree than rural districts, despite anti–urban sentiments and lack of urban qualities (Vestby et al., 2016). The existing cities are vital centers in their regions but need to adopt an urban agenda to attract people and business, while also developing in a sustainable way.

Third, conditions for urbanity and urbanism are different in Northern regions compared to central, metropolitan ones, particularly due to ambivalent urban–

rural and center–periphery relations. Because urban policy guidelines appear to target, and be based on, Norway's largest cities, they may fail to represent and affect small and medium sized cities such as those in the north. These relationships between policy and municipality must be understood if political intentions are to be realized.

Finally, Northern cities are hindered by a lack of local resources and skills needed to transition into emerging cities. Ultimately, these trends obstruct the successful adoption of sustainable urban policies in Northern cities.

In this article we present five different study topics that need to be addressed to facilitate sustainable urban planning in small and medium-sized cities in the north. The studies consider different ways to plan for climate-friendly societies, taking into account the specific climate and demographic conditions in this region. These studies were developed in close collaboration between researchers at Nordland Research Institute and Nord University in Bodø. We present both ongoing and future research projects and ideas.

WASTE MANAGEMENT AS A CIRCULAR ECONOMY

In the European project Elighthouse (http://www.elighthouse.eu), we studied how waste can be utilized to produce energy and how waste can be recycled for new products. Increasing volumes of waste are by-products of our consumer society, especially in cities where it is both a challenge and an opportunity. Our study examined the transformation of waste management from a linear process (collection to disposal) to a circular approach (using waste as fuel to generate power and recycling waste) to reduce greenhouse gas emissions. The circular approach is feasible because of the increasing need in the global economy for primary raw material and the need to reach national climate goals. The experiences from the Elighthouse project also show that a circular economy can be a strong driver of product innovation and product upgrading.

The focus of waste management planning pertains to waste flows, such as water supply and treatment; wastewater treatment, including collection, wastewater treatment plants and recovery installations; and solid waste management, including solid waste collection, separation facilities, transportation logistics, landfills and incineration facilities (Urbanmetabolism.weblog.tudelft.nl, 2018). A waste management program, including recovery, reuse and any material mining, must be planned to reflect the different waste flows, the different scales as well as the differing infrastructures systems in each city. However, one of the challenges is the lack of reliable waste statistics at the local and regional levels to support planning and decision-making.

To apply a waste management circular economic model to urban design and planning, the Elighthouse project uses the concept of urban metabolism. This model framework shows the complex flows of urban systems – e.g. water, energy, food, people – as if the city were an ecosystem. We use this concept to analyze how urban areas function considering their resource use and underlying infrastructures. This modeling also reveals the relationship between human activities and the environment and can be used to shape the city in a more sustainable way. The analysis highlights how municipalities organize their sectoral activities and the possible lack of collaboration between different sectors. Additionally, public and private collaboration is needed to encourage waste management and to ensure green value creation and smart solutions by using waste as a resource in new products or production processes.

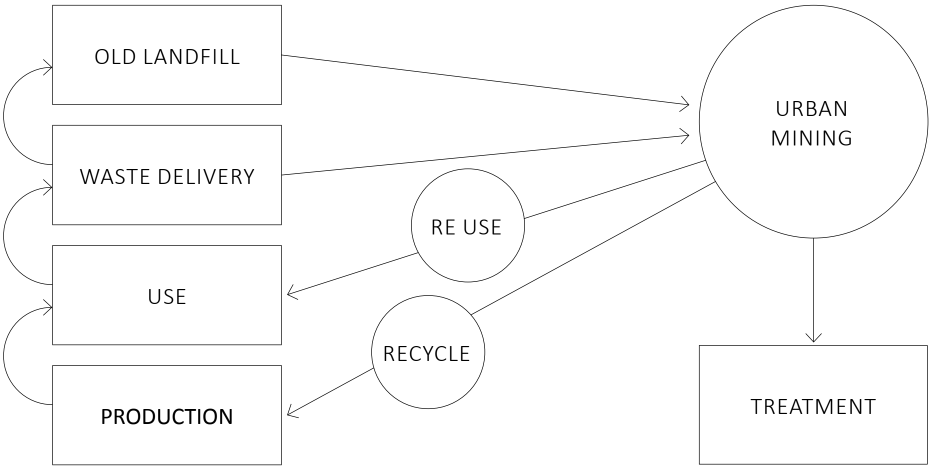

FIGURE 3: Material life cycle. GRAPHIC BY authors

TRANSPORTATION AND INFRASTRUCTURE

Transportation contributes extensively to polluting the environment and is therefore critical to take into consideration when planning future environmental-friendly cities (NTP 2018-2029, 2017, Chapman, 2007). In the north of Norway, some geographical characteristics, important for transportation infrastructure, add challenges to the planning process. These aspects include a cold climate, heavy winds and storms, polar nights, remote and sparsely populated areas, a topography of fjords, mountains and steep hillsides, and limited alternative transportation routes and modes.

FIGURE 4: Saltfjellet - a large mountain range between urban centers in Northern Norway.
PHOTO BY: Mathias B. Reinar

In addition, the various modes of transportation need to be considered carefully. Let's take transition to electrical vehicles as an example. The transition will reduce greenhouse gas emission and, to some degree, vehicle noise. However, there are some challenges related to this transition. First, the dust problem created by vehicles will not be reduced. Second, the transition requires battery charging infrastructure to be in place, which can be achieved relatively easily in large cities, but will be more challenging to achieve in smaller cities with their remote surroundings. Third, the cold climate, which characterizes Northern areas, will represent an additional challenge to the battery capacity of electrical vehicles. Fourth, subsidizing electrical vehicles may contradict efforts to increase the share of walking, bicycling and use of public transport. When users of electrical vehicles receive free use of toll roads and free parking, the costs of driving will be so low that many consumers will prefer driving instead of walking, bicycling or riding public transport.

Another example comprises the measures aimed at increasing the share of walking, bicycling and public transport use. This policy will require investment in walking and cycle paths and/or sufficient public transport capacity. In a large city with high volume of road users, this may be feasible and effective to do. However, in small cities, the volume of road users will be too low to make this an effective measure. Budget constraints may also limit the possibility of building necessary infrastructure (Skjeflo et al., 2016). The cold climate in the north may be an additional obstacle to achieving a high share of walking and bicycling in the region.

A third means of reducing pollution from carbon-emitting transportation is by reducing the need for transportation in general. This measure may be the most relevant and effective measure in small cities and the most challenging in large cities. In small cities, there may be more opportunities to build houses closer together, thereby reducing transportation needs.

Finally, conflict between different goals often appears in urban planning in small, Northern cities (Skjeflo et al., 2016). New business activity is, for example, usually welcomed since it creates opportunities for growth and work for the city's employees. However, this activity could conflict with the objective of reducing transportation needs if the activity is located far from the city center. Decision-makers may feel forced to follow private owners' wishes even if they contradict the goal of building a more sustainable city.

FIGURE 5: A snowy challenge for bikers. PHOTO BY: Mathias B. Reinar

QUALITY OF LIFE AND PUBLIC PARTICIPATION

Urbanization and centralization are ongoing social processes in Nordland County in Northern Norway, affecting the population and their quality of life. A sustainable urban development requires the active involvement of citizens and critical reflection on the paths of societal development. Participation of citizens in policy design also increase quality of life. This is because participation is meaningful, builds trust, and stimulates policy and planning which facilitate a high quality of life. Citizen participation processes are, however, challenging in practice.

Quality of life is conceptualized and studied in different ways. Barstad (2016, p. 9) states that quality of life "involves a holistic perspective on the lives of individuals and groups, both at a specific point in time and over the lifetime." Scholars and practitioners have developed several subjective and objective (statistics-based) indicators of quality of life (wellbeing) to inform policy makers and planners (see figure below for an overview of statistical indicators – text in black). Although statistical indicators are important inputs, their use has weaknesses. The generalized nature of these indicators obscures the voices of citizens. They also do not allow for processes and mechanisms that improve quality of life. In addition, crucial values that are important for maintaining the environment are currently under-studied (see text in white in the figure below).

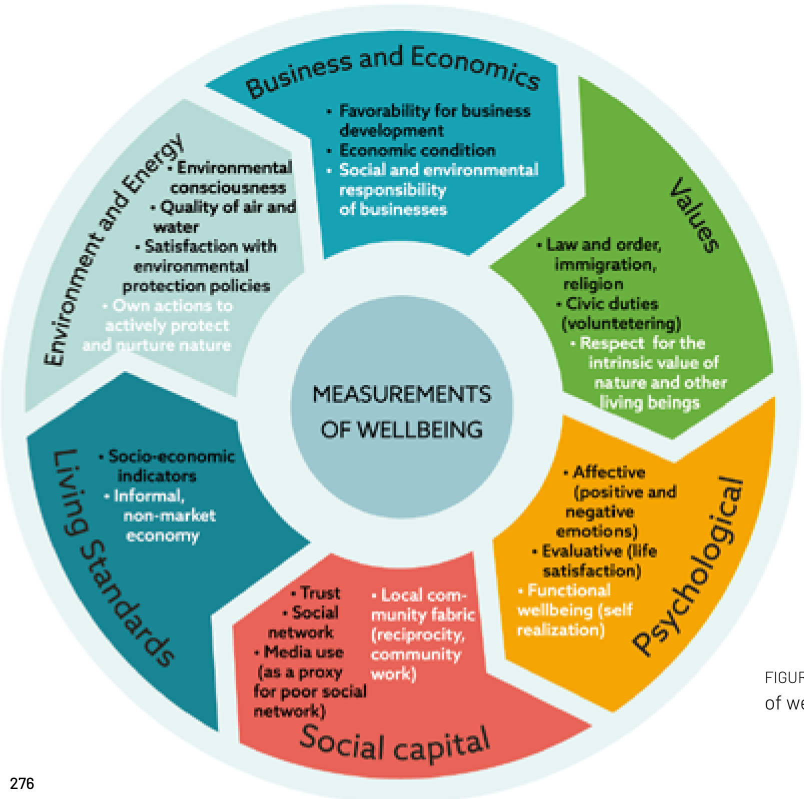

FIGURE 6: Measurements of wellbeing / quality of life

The scholar Manfred Max-Neef, asserted the important role of public participation in identifying a high quality of life. He emphasized that goods and services (satisfiers) are the means to an end, and not an end in themselves. He argued that the ultimate end is human development, and that human development is the satisfaction of fundamental human needs. He and his colleagues identified a list of nine axiological and four existential needs (see figure below for details). They arranged these fundamental needs into a matrix to assist in participatory identification of satisfiers that improve quality of life.

		EXISTENTIAL NEEDS			
		Being (individual or collective qualities)	Having (resources, tools, institutions, norms)	Doing (personal or collective actions)	Interacting (settings and environments)
AXIOLOGICAL NEEDS	Survival				
	Protection				
	Affection				
	Understanding				
	Participation				
	Idleness				
	Creation				
	Identity				
	Freedom				

TABLE 1: Quality of Life. Graphic by authors

The workshop method based on this theory has proven to be a useful tool for citizen participation. It is flexible and effective at identifying challenges and solutions relevant to policy design and urban planning. One important contribution of this work is highlighting the interdependence between human development and environmental sustainability. Synergic bridging of satisfiers fulfills several fundamental human needs and can simultaneously protect the environment (Guillen-Royo 2010, Guillen-Royo 2016). As an example, one study identified restructured work schedules as a synergic bridging satisfier. Study participants highlighted the benefits of restructuring in terms of reducing stress, increasing time spent with family and reducing driving time, thus achieving the twin goals of human development and environmental sustainability.

In future research projects, we will test this method in towns and cities in the north of Norway, in collaboration with local governments in Nordland County.

With participation from selected segments of the population, workshops will be set up to explore the opportunities and hindrances of sustainability-oriented policies on quality of life. The outcome of these structured workshops will be proposals for local and regional policies for increased sustainability and quality of life in towns and cities in Nordland.

SUSTAINABLE AND DIVERSE CITIES

Cities in Northern Europe are increasingly inhabited by people with diverse cultural backgrounds. The social, economic and environmental sustainability of cities requires the capacity to live with differences. Recent increases in refugees and asylum seekers pose new challenges for cities, such as the need to provide affordable housing, transportation, community meeting spaces and economic opportunities. The research project Cit-egration[2] aims to produce new applicable knowledge on innovative multicultural integration activities that help us to live with difference, enhance integrative interaction and develop cities – granting diverse populations the right to physical spaces, participation in urban life, and the ability to shape the city as equals.

FIGURE 7: A meeting at the public library in Bodø. PHOTO BY: Øyvind Hunstad Ballari

FIGURE 8: Locals and newcomers. PHOTO BY: Øyvind Hunstad Ballari

This on-going integration research project analyses and develops innovations from two key Northern cities with significant immigrant populations: Bodø and Tromsø. The cold climate of the north brings certain challenges related to creating new meeting places, indoors and outdoors, but the increased diversity has led to a wide variety of new and innovative integration activities aimed at connecting newcomers and established residents in urban meeting places. The research is conducted in close cooperation with voluntary organizations, local government, private persons and entrepreneurial businesses focused on generating knowledge and solutions that support social, economic and environmental responsibility.

URBAN GOVERNANCE AND LEGITIMACY

Developing a sustainable city with less greenhouse gas emissions, less energy consumption, less pollution and so on, requires measures reaching far into the way citizens live their lives. Therefore, the involvement and commitment of the urban population requires action beyond traditional public consultations and written planning statements. Sustainability poses a challenging question for urban governance: How to take necessary steps towards a "green city" in a legitimate way?

The legitimacy of urban planning is often framed as a distinction between input and output. Input legitimacy refers to the procedural aspects of a planning process, through inclusion and participation, accountability and transparency, and the deliberative qualities in the processes. Output legitimacy relates to the

FIGURE 9: A model and drawings at Bodø ByLab. PHOTO BY: Mathias B. Reinar

outcomes of these processes, and the policies' effectiveness and problem-solving capacity. Also, vital for the output legitimacy of urban policies is the polices' transformative capacities towards a more climate friendly, green and just city. In practice, the legitimacy of urban planning is assessed with a combination of input and output legitimacy.

In Bodø, the municipality is setting up an Urban Living Lab. The Bodø ByLab will look "at the whole society perspective in city development," and, in doing so, "connect public health, education, welfare, environment, culture, governance, business development and technology development together," according to the city municipality's web page. The Lab itself is both a physical place located in the main library and a virtual space. By establishing the local planning office in the public realm, the local government wants to engage citizens in discussions about the city's development. The Bodø ByLab is therefore an interesting case for the study of legitimacy in urban governance, as it provides an opportunity to explore the ways in which the local government and citizens interact, share ideas and co-create the new city.

CONCLUDING REMARKS

The research community at Nordland Research Institute and Nord University in Bodø will be establishing a research effort to explore the topics discussed in this article as well as other related subjects in the coming years.

A primary focus will be the city of Bodø, the capital of Nordland County in the north of Norway. Bodø is an interesting case to study for many reasons. In the coming years, it is expected to experience one of the major city and regional development projects in Norway. The impetus of this project was the decision to move the airport further away from the city center, and, in doing so, release large areas for development. The municipality sees this project as an opportunity to transform the small coastal city into "the smartest city in the world," according to the municipality's webpage. Implicit in this "smart" vision, is the assumption that the city will be sustainable and climate-friendly.

Scientific research, the dissemination of findings, and engagement with the public are vital to insure the success of Bodø's urban transformation. Our research community hopes to participate in various activities which aim at exchanging knowledge and ideas concerning various urban and environmental issues. One such forum has already been initiated: the debate series Lytring, held every month in the city's public library.

The development of a sustainable and climate friendly city will require research and planning perspectives that include dilemmas, paradoxes and critical thinking if we are to succeed in making Bodø "the smartest city in the world." This dynamic process will include trade-offs between values, interests and visions for the future, the inclusion and exclusion of actors, perspectives and salient issues in the planning processes and the balancing of private and public interests. For Bodø, being climate-friendly will be particularly challenging as its transformation is premised on the construction of a larger airport, both increasing air traffic and resulting in more greenhouse gas emissions.

In our opinion the examination of the five research topics identified in this article is vital to guide the sustainable urban development of other small and medium-sized cities in the North. Faced with the challenges of climate change and the need for new planning practices, we invite planners, policy makers, developers, businesses and interested citizens to further engage with us to shape an agenda for sustainable Northern urbanity.

ENDNOTES

1 As of today, 70 per cent of all greenhouse gas emissions come from cities, 60 per cent of all energy consumption takes place in cities and 70 per cent of all waste is produced in cities.

2 *Cit-egration-Sustainable diverse cities: Innovation in Integration* is funded by the Norwegian Research Council BYFORSK-initiative and the SAMKUL-programme (270649). The project runs from 2017-2021.

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THE YAMUNA RIVER PROJECT
AN ESSENTIAL FUTURE

IÑAKI ALDAY, PANKAJ VIR GUPTA

FIGURE 1: A man prepares to bathe in the Yamuna River in Delhi, India. The Yamuna, one of the most polluted rivers in the world, is considered to be holy. Bathing in the waters is a spiritual cleansing rite. Photograph by Yogesh Gupta, National Geographic. Retrieved from: https://www.nationalgeographic.com/photography/photo-of-the-day/2017/06/delhi-yamuna-river-bath/

INTRODUCTION

The Yamuna River Project (YRP) aims to help the city of New Delhi and its citizen stakeholders reimagine and transform the sacred, yet polluted Yamuna River as it flows through India's capital. As one of the most rapidly urbanizing mega-cities in the developing world, New Delhi has serious challenges, revealing inadequacies in planning, urban design, and social equity. These limitations are emerging at a time of economic uncertainty and ecological fragility. As a result, the citizens of the world's largest democracy live amidst unprecedented environmental degradation.

In addition, existing governance structures have been hard pressed to keep up with the pace of the complex, rapidly evolving dynamics of climate change. Toxic air and septic waters are simply collateral damage in this circumstance. Overburdened public health systems are fraying as more citizens are exposed to the adverse consequences of these environmental ills in daily life. These millions continue to suffer, often silently and without recourse, as they inhabit the city.

The Yamuna River Project confronts the dilemmas of Delhi's urban reality, with a precise, analytical, multi-disciplinary, research-based methodology. This

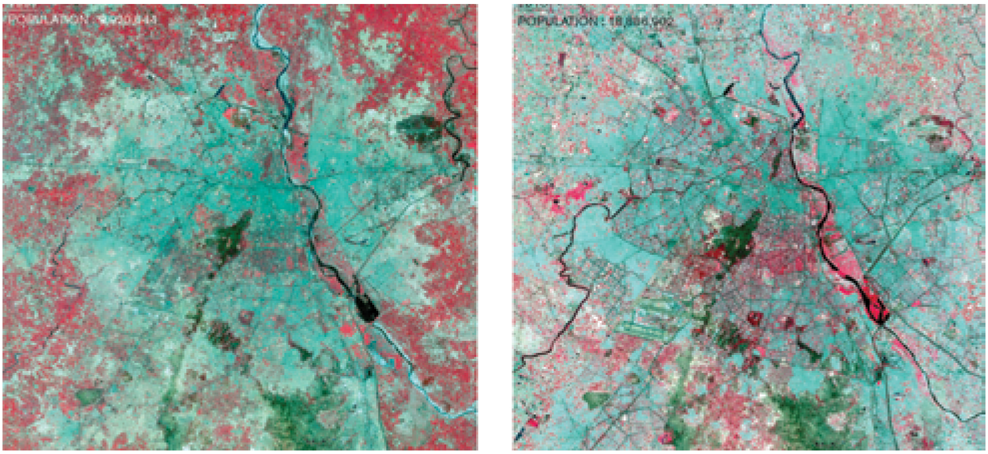


FIGURE 2 : ↑ The Yamuna River Project proposes a "Green Infrastructure" vision for Delhi which revitalizes the Yamuna River Floodplain, transforms the city's open drains into linear park systems, and connects the rural agricultural belt and forested lands of the southern ridge. Image by July Qui

FIGURE 3: ↓ Delhi's Exponential Expansion. The red color depicts vegetation and cyan depicts hardscape; Between 1991 and 2016, Delhi's population doubled and its forested area decreased by 35%. Research conducted by Matthew Reidenbach, Assoc. Professor of Environmental Sciences, UVA

approach facilitates a dynamic collaboration between the intellectual speculations generated within a University and their practical application for a range of knowledge partners governing the city, including municipal authorities, political leaders, citizens' advocates and non-government organizations.

THE RIVER

The Yamuna River is a living ecological entity with her own seasonal cycle of flow, complex hydraulic dynamics, and shifting floodplain territory. For centuries, the river has existed as a significant geographic presence within the northern Indian landscape. In myth and in religion, in prose and poetry, in song and in lore, the Yamuna has been immortalized as a primordial Goddess. For centuries, the river constituted not just the defining axis, but also the ecological and agricultural lifeline of the many settlements preceding present day Delhi. It is impossible to imagine the city of Varanasi without the illuminating presence of lamps adorning the Ganga; or to disengage the Holkar capital of Maheshwar, famous for its weavers and looms, from its anchor on the banks of the Narmada, where the rising humidity provides an atmospheric condition perfect for blending cotton fiber with silk, creating the famed Maheshwari silk. Delhi and the Yamuna were once so conjoined. Even today, the sandstone walls of Mughal era monuments abutting the floodplain reveal watermarks of the Yamuna. But all this is in the past. Long gone are the days when the citizens of Delhi swam, fished, and strolled freely on the banks of the Yamuna.

FIGURE 4: "The Dead Yamuna River." The Yamuna River carries the refuse and contains 0% oxygen as it passes through Delhi, rendering its waters devoid of all life. Image by Lauren Nelson

FIGURE 5: "Delih's Nallahs." Historically small rivers and streams, Delhi's drains and subdrains carry untreated wastewater and are used as informal dumping grounds. The informally constructed neighborhoods of a burgeoning population crowd their banks. Photo by Randhir Singh

In this age, characterized by geologists as the Anthropocene–when patterns of human settlement are significant influencing forces on environment and climate–urban populations in many mega-cities have far exceeded the carrying capacity of their designed infrastructure. This is the case in New Delhi, and as a result the Yamuna has been reduced to a poorly managed sewage drain, absent both from the urban landscape and from the public imagination. The fight for citizens' survival inflicts even deeper damage to an already fragile ecological circumstance. Urban development, justified in the name of civic prosperity, is often misleadingly defined in opposition to environmental security. In the hardscrabble urbanity of the present India megacity, there is little room for the ecologically sacred.

THE DIAGNOSIS

Originating in the Himalayas, and emerging from the Yamunotri glacier, the Yamuna River negotiates dams and barrages, irrigating thousands of acres of agricultural land, before it flows into New Delhi. North of Delhi, the volume of fresh water in the Yamuna is sufficient to dilute organic matter and fertilizers, absorb pollution from pesticides and agricultural runoff, while maintaining a level of dissolved oxygen capable of supporting aquatic life, birds, and vegetation. However, the river receives an unholy welcome upon her arrival in Delhi.

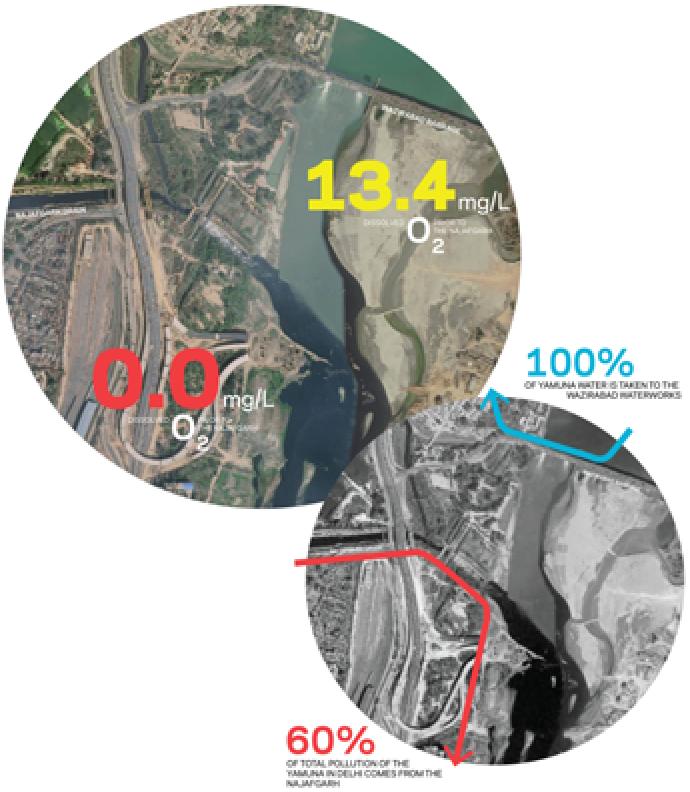


FIGURE 6: "The Cut and the Najafgarh Drain." During the dry season, when the Yamuna reaches Delhi at the Wazirabad Barrage, 100% of the natural flow of the river is cut. Sewage, wastewater, and trash from the Najafgarh Drain becomes the new river flow. Research conducted by Winston Lung, Professor of Civil and Environmental Engineering

At the Wazirabad barrage, the Yamuna's water is dammed, and part is diverted to partially quench the capital city's insatiable thirst. Just after this Barrage, the Najafgarh Drain, formerly the perennial Sahibi River, provides the only flow into the Yamuna and bringing with it sixty percent of the river's total pollution load. Comprising of untreated sewerage, solid waste, industrial and chemical effluent, and urban detritus, the flow of the Najafgarh drain depletes the water of all oxygen content, rendering it incapable of supporting any form of life.

The quality of the water is not in fact the problem. Billions of dollars have been invested in large water-based infrastructure projects, without achieving any substantial success in cleaning the river. Polluted water is the consequence and an indicator of 150 years of urban evolution, an empirical measure of the last fifty years of rapid, largely unplanned growth, and, in summary, of severe social and environmental inequality in the city. British rule changed the historic relation between Delhi's population and the water, transforming both a sacred and a secular interface, into a commodity of uncertain origin. From inhabiting the many 'ghats' that lined the river and offering an unobstructed experience of civic and religious

FIGURE 7: "Flooding Risk." Floodplain encroachment and climate change have placed Delhi on the edge of catastrophe. A 100-year flood event would breach the embankments lining the river with devastating consequences for the millions of citizens who now reside on the former floodplain. Drawing by the 2014 Re-Centering Delhi Design Studio

life amidst the Yamuna river, Delhi's population grew detached from the river, receiving a poorly regulated, often contaminated, and, at best, intermittent supply of precious water, through an intricate maze of pipes and meters. A water mafia sprang into action, quickly monetizing an opportunity to drill illegal wells, pump unregulated water, and supply tankers to a parched populace.

A larger problem is that Delhi's citizens are now completely detached from their river, only part of a larger detachment from the formerly shared consciousness of public space, and, in fact, from the concept of a 'commons'. This detachment is the underlying cause of Delhi's environmental dilemma. The Yamuna river, perceived as an incarnate Goddess, is incapable of supporting physical life.

The legal protections offered to the Yamuna (and to the Ganges river), entrusted with the rights of living entities, fail to deter the agencies that poison them. This contradiction reflects the dilemmas of a complex society, confronting a critical moment of exponential population growth, social inequality and convoluted municipal governance. The perennial flows of raw sewage from the capital city into the Yamuna, are simply a reflection of the inequity of a city without planning and with a severe lack of infrastructure. Thus, the floodplain of the Yamuna reveals urban slums of unprecedented density, without any provision for the safe supply of drinking water, nor for sewerage treatment, without education and health facilities. This disenfranchised population, encroaching upon the floodplain, scraping a meager livelihood from the margins, suffers again from an unrelenting cycle of monsoon floods.

The restoration of a healthy equilibrium between the river and the city is also a matter of survival. India faces the consequences of climate change on enormous scale, with monsoon floods killing thousands of people every year, and causing significant damage to urban infrastructure, ruining lives and livelihoods. The consequences of a one hundred-year flood event–likely to occur more frequently with increasing global warming–will be devastating. Urban sprawl, fueled by the lack of planning, has reduced the available forest cover. Ecological and agricultural area per inhabitant in the National Capital Territory of New Delhi has shrunk dramatically in the past few decades. The reduction of forested area, diminished local food production and poor soil permeability, has created a social and ecological crisis of extreme urgency. The effects of climate change are seen not only in more recurrent floods, but also in droughts and heat island effects with substantial impact on the most vulnerable populations.

GOVERNANCE

Political leadership, limited by the relatively brief tenure of elected office, and challenged by the pace of change, often resorts to political grandstanding. In New Delhi, policy-making often seems at an impasse, unable to conceptualize a systematic, long-term urban vision for the humanity that constitutes the city. Governments, confronting the limitations of five-year long electoral cycles, often default to short-term solutions, perpetuating an illusory construct of urban progress. Increasingly, the call for "smart cities", automated and propelled by artificial intelligence, is seen as a panacea. Over the past decade, it has become increasingly evident that no single entity–elected or appointed to 'lead' the city–has the experience to 'resolve' rapid urban degradation. In fact, it has become evident that the existing structure of urban governance may be part of the problem. That is, governance structures that are designed to operate with a historically limited mandate, are now being asked to address novel problems that demand both agility, and cross-disciplinary functionality. A plethora of municipal agencies, often working at cross-purposes, without accountability, fail to address the synthetic nature of the city. Thus, agencies tasked with water-supply and sewage treatment have little to do with entities that manage solid waste management;

development authorities entrusted with planning housing and work-space, consistently fail to estimate the growth of the city, condemning millions of people to forage for a foothold in squatter settlements lacking even the most basic amenities; public transportation administrators fail to synchronize existing and new multi-modal transport systems.

Within this fragile equilibrium, active engagement with best-practice models for identifying, synergizing, and upgrading urban systems, governance and ecology, has never been more critical.

THE METHODOLOGY

The Yamuna River Project has sought to engage this dilemma with a multi-faceted approach. Applying broad based, intellectually diverse, research experience, the Yamuna River Project has forged a credible partnership with existing governance structures and established a paradigm for influencing significant remediation policies. Developing a transparent, collaborative and open-source methodology, the project functions as a critical front for the confluence of academic leadership, with cultural, environmental, and political systems of governance.

The project methodology questions and investigates the causes and origins of Delhi's environmental situation from many perspectives–historic, social, technological, environmental and cultural. A critical element of this approach is the commitment to the development of a vision, a conceptual framework, to explore potential avenues for transformation. This vision reimagines the urban environment, evaluating and testing ecologies that facilitate sustainable urban growth and

FIGURE 8: "India Gate Biodiversity Park and Cultural Center." Image by Joseph Brookover Jr.

accountable governance. Finally, the Yamuna River Project proposes speculations: holistic interventions that define systematic urban strategies and generate new typologies that respond to the specificity of Delhi. The thesis of this approach postulates that 'water is the consequence', reflecting the ethos of the present urbanity.

The breadth of this methodology is only possible in the context of an independent research university, acting as a multidisciplinary think tank. As defined by George Steiner (Universitas, 2013), the pivot of the university is its intellectual and civic freedom, and its capacity to engage in independent excellence, remains unfettered by the utility of the knowledge so produced. The university has an almost infinite capacity to add and combine disciplines and areas of expertise, therefore developing innovative interdisciplinary connections. Institutions like the University of Virginia are thus multicultural by nature, nimble enough to deploy academic resources across diverse cultural environments.

On the other hand, contradicting or complementing Steiner's vision, today's leading universities feel the urgency of engaging with the most critical issues of our time, extending their reach and collaborating beyond the campus. The implication on these urgencies requires dealing with the complex issues and the difficulties of management and implementation. To that end, multidisciplinary teams become key, ranging from abstract and very specific areas of knowledge to disciplines that engage naturally with politics, social dynamics, design, or planning.

The intellectual apparatus for the Yamuna River Project encompasses multiple and interrelated points of view: ecology and culture, history and infrastructure, economics and design, are some of the many combinations explored. The vision for the planning, and creation of dynamic public spaces emerges as a conclusion drawn from detailed investigations of the physicality of the city fabric, and the armatures of governance, culture, religion, ecology, public health or infrastructure. Conceptualized as systems, the layers of complexity of the city and its ecological territory, are intertwined as a "design methodology."

THE IMPACT

The Yamuna River Project directly engages decision makers and municipal agencies, as well as social and environmental organizations, who have been working in Delhi to reverse the situation of the Yamuna.

Our primary partner in India has been the Delhi Jal Board (Delhi Water Authority), which is confronting the mammoth task of creating infrastructure for water and sewerage treatment. In 2016, after a series of meetings with the Indian Government, Delhi Government, and related governmental agencies, The University of Virginia and the Delhi Jal Board signed a five-year Memorandum of Understanding (MOU) to study Delhi's polluted watersheds and place the Yamuna's restoration at the forefront of public consciousness. Through their partnership with the Yamuna River Project, forward thinking leaders at the Delhi Jal Board have, for the first time, started to integrate urban design and planning strategies into their development manifest.

Through a series of public research exhibitions and symposiums in India and with an established diplomatic ally in the Spanish Embassy in India, the Yamuna River Project has garnered direct public support from the Lieutenant Governor of Delhi, Shri. Anil Baijal; Minister of Housing and Urban Affairs, Honorable Hardeep Singh Puri; the Secretary of the Ministry of Water Resources, Mr. U.P. Singh; the Joint Secretary of the Ministry of Commerce and former CEO of the Delhi Jal Board (Delhi Water Authority), Mr. Keshav Chandra; President of YES Bank, Dr. Chubi Saturvedi; and local and international financial institutions such as the YES Bank and the European Investment Bank.

The Delhi Government has begun to take a critical first step towards the restoration of the Yamuna by consolidating a few of the municipal agencies that deal with water, flood control, irrigation, and environment, under a single-point leadership structure which will streamline decision making and increase interagency coordination. Most significantly yet, the Ministry of Water Resources is now considering the empowerment of a Yamuna River Development Corporation (overseen by the Yamuna River Development Authority) for which UVA and YRP would serve in an advisory role as knowledge partner.

If fully implemented, YRDC would be tasked with planning, coordinating, and delivering the sustainable restoration of the Yamuna river, its tributaries, drains, subdrains, and all water bodies in Delhi's National Capital Territory (NCT), culminating in a comprehensive proposal for the restoration of the Yamuna River that continues to implement integrated research approaches and is implementation ready. YRDC would exercise regulatory control over all water bodies within the NCT, would be responsible for monitoring water quality and hydrology, determine permissible ecological activities and development within NCT water bodies, and prepare policy directives for best practice management processes. These activities would be accompanied by awareness campaigns to encourage local communities to take ownership over the management of their water resources in accordance with the comprehensive vision.

Because of this institutional and public support, the Yamuna River Project and our partners are advancing towards a pilot project for the restoration of a major subdrain of the Najafgarh Drain which will serve as a case study for the future recovery of other subdrains, major drains, and eventually, the Yamuna herself.

FIGURE 9: "Sewage Treatment Plant Restoration and Hybridization." This project creates a hybrid sewage treatment plant, utilization engineered infrastructures and natural phytoremediation processes. New public spaces and a market are designed to connect adjacent neighborhoods. Image by Brittany Duguay

THE VISION

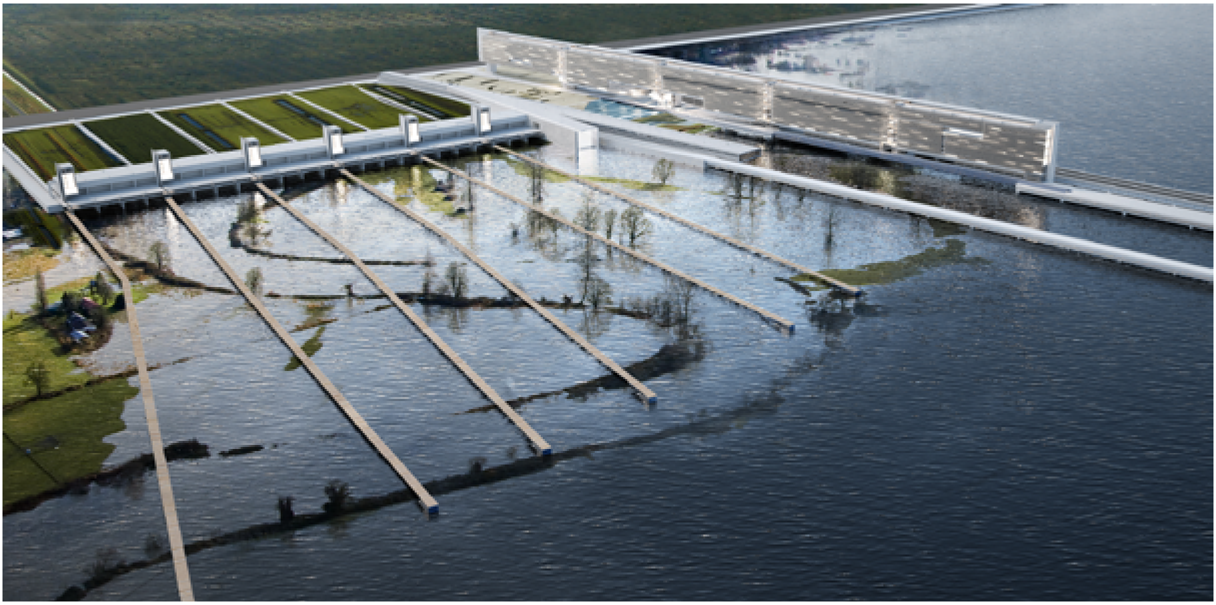
The dilemmas of New Delhi–or for that matter, any Indian or global megacity–a critical level of air and water pollution, scarcity of affordable housing, acute shortage of community space, are not radically different from the dysfunction of some European or North American river cities only a few decades ago. Although Delhi and the Yamuna represent an acute urban crisis, this is only one of the many similar crises on the planet, in which a lack of planning, rapid growth and climate change redounds as a lack of basic infrastructures and cultural attachment. The resulting social inequality is dramatically visible in the ecology of an environment that once was the reason for the city to exist–its rivers–and in the pollution of the most precious substance for life–its waters.

The remedy for New Delhi's defiled Yamuna, and her once sacred waters, will need to holistically address the causes of pollution, and redress the inequality within the city. The Yamuna River Project seeks to foster this change. We recognize a basic fact of the Anthropocene era–the cities that we design and make now, are the cities that we shall inhabit in the future and with which the planet itself shall have to live. It is present day human intent and intervention that shall ensure the sustainability and survival of the future city–a city predicated on our ability to secure ecology from our own advances. We therefore equate social prosperity with ecological stewardship. The Yamuna and all its tributaries, the flows and the floodplains, are the base for reformulating Delhi's commons. They are to become the public space and ecological spines of the new socio-ecological structure of the city.

As co-founders of the Yamuna River Project, we have marshaled the resources of the University of Virginia and forged an innovative collaboration with the Delhi Jal Board, generating meaningful solutions for the crises afflicting the Yamuna River. Developing a transparent, collaborative, and open-source methodology, the Yamuna River Project functions as a critical front for the confluence of academic leadership, and cultural, environmental, and political systems.

We are optimistic that many restorative opportunities are latent in the neglected space of interaction between River and City. What if the Yamuna River floodplain may be reimagined as an urban nucleus, communicating a value system that situates the capital city within its original riparian ecology? In this sense, the Yamuna River Project is entrusted with the task of redefining a sanctuary within a megacity. The new reality of the Yamuna River would, once again, be tethered to an awareness of the sacred, celebrated in image and in song. In a world where we have vanquished nature, the river city relationship would be an inseparable ethical identity. The citizens of the city would make a commitment to secure and nourish the river–making her sacred again–and New Delhi would forge another identity, a commitment to a new ecology.

FIGURE 10: "Hybrid Bridge Social Housing." Available space for development is in short supply in Delhi. This project utilizes the bridges that span the Yamuna River to construct new social housing typologies. Photo by Eric Barr



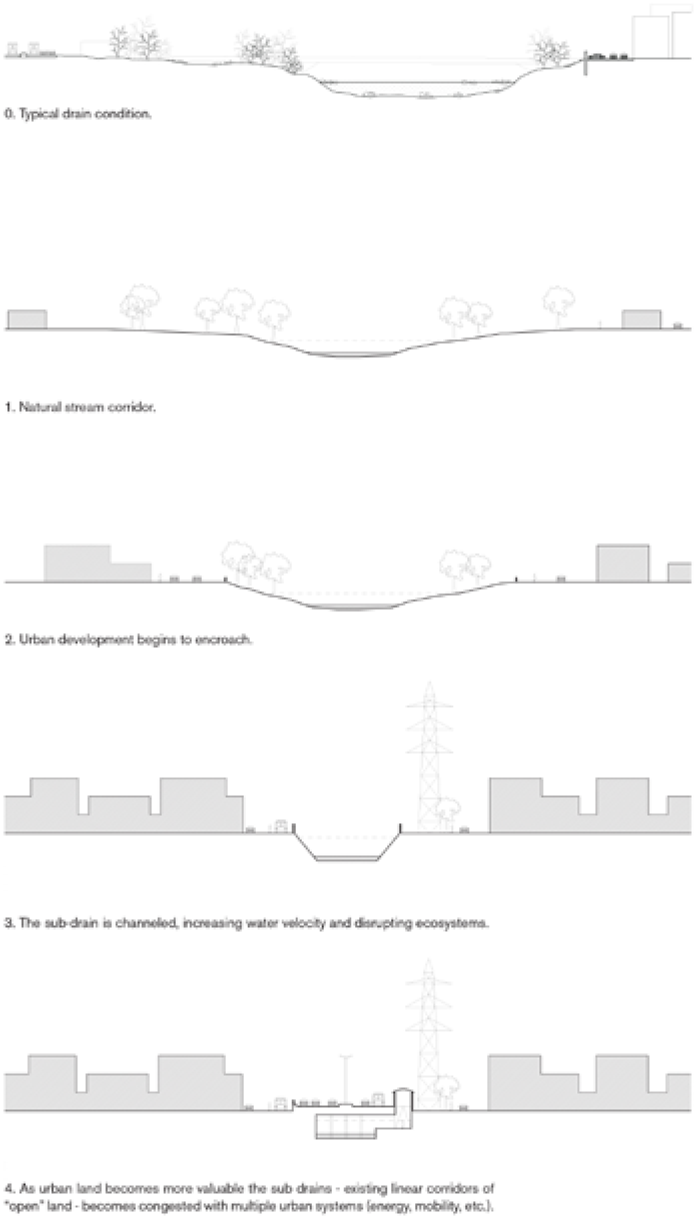
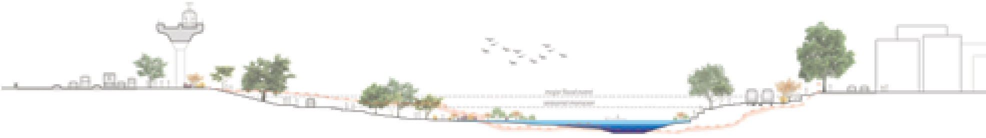


FIGURE 11: "Drain Conditions." This series of drawings depicts typical drain conditions in Delhi, from natural stream corridors to heavily embedded and covered in urban contexts. Drawing by Laurence Holland



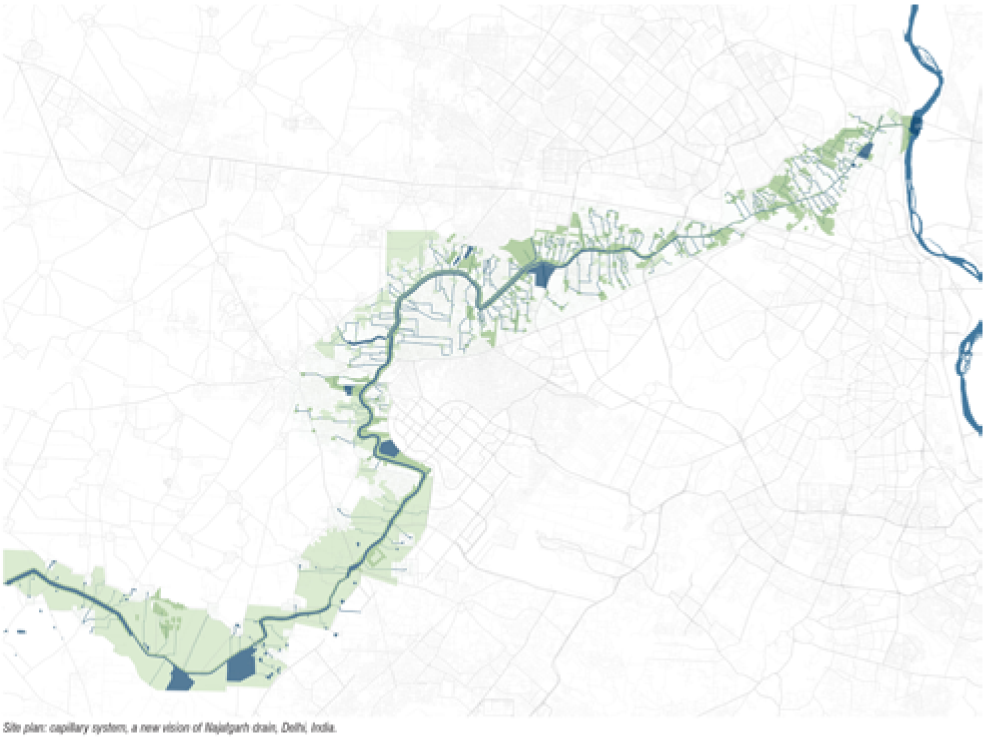


FIGURE 12: ↑"Drain Excavation." This project proposes to excavate the existing drain systems, creating new sludge treatment parks, public transportation options, and increasing vegetative cover. Drawing by Josh Aronson

FIGURE 13: ↓"The Drain Capillary System." As a necessary step towards revitalizing the Najafgarh Drain and the Yamuna River, this project proposes a continuous wetland park that acts as an urban water capillary system that treats agricultural and household waste. Drawing by July Qui

FIGURE 14: ↑"Subdrain Seasonal Park." Delhi's subdrains carry trash and untreated wastewater into the Yamuna River while also acting as barriers between neighborhoods. This project transforms the subdrain from its current "backyard" condition into a seasonal park that bio-remediates water, creates public space, and provides opportunities for new social housing developments. Drawing by Sosa Erhabor and Andrew Morell

FIGURE 15: ↓ "Floodplain Marsh Recovery." Remaining marsh ecosystems are under extreme pressure from informal development and poor sewage systems. This project recovers the marsh ecosystems and creates a new public park and ecological education centers. Image by Zhilan Song

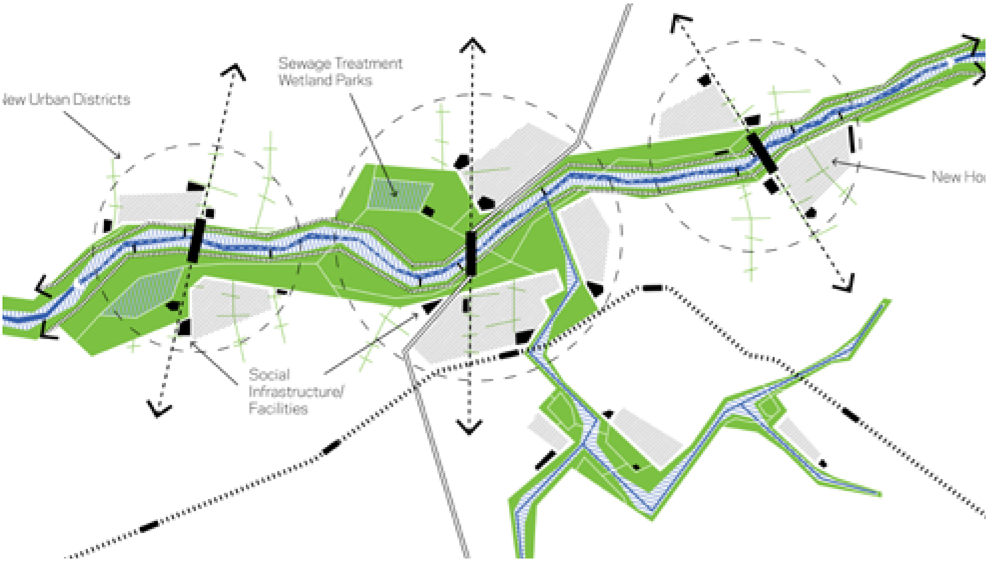


FIGURE 16: "Najafgarh Drain Strategic Plan" The Strategic Plan proposes to understand that Najafgarh Drain and its tributaries as structural elements in the city: as a geographical and urban armature around which systems are organized, including public space, public facilities, urban ecologies, and slow mobility. Drawing by the 2016 Re-Centering Delhi Design Studio

ISOCARP ACTIVITIES

SMART SUSTAINABLE CITY
WHITE PAPER OF THE INTERNATIONAL SOCIETY OF CITY AND REGIONAL PLANNERS

RIC STEPHENS, IRENA ITOVA,
MAŁGORZATA HANZL, BENJAMIN SCHEERBARTH

The authors acknowledge the invaluable assistance of the speakers and attendees at the World Urban Forum 2018 "Smart Sustainable Cities" networking event in developing this paper. Further contributions came from the panelists of "International Smart Cities" session at the American Planning Association 2018 National Planning Conference in New Orleans and from the specialists and professionals gathered and collaborating with ISOCARP .
Some of those who assisted are shown and identified in group photographs below. The individual contributions can be viewed on the ISOCARP website in the publications section, their contributions are also listed in the Appendix in the end of this paper and referenced in the text.

FIGURE 1: ↑ ISOCARP organised the World Urban Forum 9 "Smart Sustainable Cities" networking event to focus on concrete examples of implementing the New Urban Agenda. Panelists included: ICLEI Deputy Director Soumya Chaturvedula, Royal Town Planning Institute Chief Executive Trudi Elliott, ISOCARP Vice Presidents Małgorzata Hanzl and Daniele Vettorato, Malaysian Institute of Planners Honorary Secretary Datin Khalid, Canadian Institute of Planners President Eleanor Mohammed, International Federation for Housing and Planning Strategic Director Morten Nielsen, UN-Habitat Strategic Planner Javier Torner, International Union of Architects President Thomas Vonier, and ISOCARP President Ric Stephens, moderator. PHOTO BY: Ric Stephens

FIGURE 2: ↓ International Smart Cities" session at the American Planning Association 2018 National Planning Conference, New Orleans, April 24. Panelists: front row: Canadian Institute of Planners President - Eleanor Mohammed, RPP, MCIP, EP; Royal Town Planning Institute President - John Acres. Back row: APA International Division Chair - Timothy Darby Van Epp; Brookhaven National Laboratory Policy Advisor - Vatsal Bhatt; ISOCARP President - Ric Stephens; Planning Institute of Australia President - Brendan Nelson; Georgia Tech Associate Professor - Perry P Yang; UniverCities Innovation Project Developer - Irena Itova.

INTRODUCTION

The term "smart city" has recently become a popular buzzword with as many taints and shades of meaning as urban life itself. Not only does it describe the applications of technology to urban infrastructure and service provision, it has also become an umbrella containing all manner of innovative management and organization. It attracts stakeholders coming from different branches of industry, who perceive it as a chance to develop and sell products and services. Because of this successful marketing, the concept of smart city will continue to develop and be adopted, whether we as urban planners and designers, support this growth or not.

Smart city implies a systematic approach to the urban economy using telecommunication, information and communication technologies [01]. Smart City as a concept is currently understood as authorities using technology to better manage the city. Smart cities initiatives around the world are driven by the pressure on public financing, climate change, production of energy, limits of resources and rapid urban population growth. Wirz Schneider [01] lists Smart Economy/stakeholder management, Smart Buildings, Smart Mobility, Good Governance, Smart Grids and Technologies and Scarcity of resources and energy production as some of the key factors of the urban assets of smart city initiatives.

ISOCARP has been involved in "smart cities" for many years, and this is reflected in Society programming and articles in previous issues of the Review. Former ISOCARP President Alfonso Vegara was a leader in this movement. In 2004, he authored the book Territorios Inteligentes describing the Spanish national program for a regional system of smart cities. More recently ISOCARP collaborated in many global events that focus on smart cities. At the May 2016 Metropolitan Solutions conference in Berlin, ISOCARP coordinated with public and private sector organizations on smart city planning. In October 2016, Habitat III in Quito had several sessions devoted to this topic, and ISOCARP was engaged in many of these as a partner with UN-Habitat and the Global Planners Network. In 2017, the theme for the ISOCARP World Planning Congress was "Smart Communities" with an emphasis on blending technology with social, environmental, and economic planning theory and practice. These programs were revisited earlier this year at the World Urban Forum where ISOCARP organized a session devoted to "International Smart Cities", again in coordination with UN-Habitat and the Global Planners Network. ISOCARP members have also been active in promoting smart city discussions through sessions organized at multiple events including several American Planning Association conferences, Moscow Urban Forums, REAL CORP conferences, Smart and Sustainable Planning for Cities and Regions conferences, and many others[1].

As members of ISOCARP, the global network of urban planning professionals, we need to consider our primary obligation to search for solutions and to propose development which, while embracing this brand-new potential, would maintain established values of sustainable development. Moreover, we need to provide solutions which would aid planners worldwide in their daily practice to successfully use new technology to facing contemporary challenges such as climate change, rapid or shrinking growth, lack of housing, food deficiencies, and migrations among other issues. Therefore, our objective with this White Paper is to provide a disciplinary framework for the further development of smart, sustainable cities.

After this introduction, a description of smart city state-of-the-art follows. It summarizes the strengths, weaknesses, opportunities, and threats of contemporary urban technology development. Further, we present a roadmap of differentiated approaches to the smart, sustainable cities theme as crowd-sourced from both our members and several external, international planning organizations. Summaries of the main inputs accompany the presentation. Stipulations about the future path of smart city development conclude the article.

STATE OF THE ART. SMART CITY AS A FIELD OF THE CONTEMPORARY ECONOMY

OPPORTUNITIES

Smart tools which are necessary to create smart cities are being used in a variety of fields including manufacturing, transportation, agriculture, inventory control and logistics, health-care to name a few. Only recently have smart tools been used to manage urban systems or gather information for planning. A typical urban smart tool application might enhance resources management to improve efficiency, reduce loss, or reuse or recycle water, energy and land. Smart mobility, as another promising planning-related application, covers both autonomous vehicles and various transportation schemes. For example, the use of smart technology can enhance the management of transportation infrastructure and the information from Smart sensors can influence user behavior and, consequently, actual traffic flows and mode choices.

As smart technology and applications become more common they have the potential to improve basic living conditions and address various problems of contemporary urban living. Starting at home, smart apps might improve safety and provide permanent access to healthcare. Smart technology has the potential to reduce crime, improve work and the work trip experience, mitigate unhealthy climate conditions and generally create a more favorable milieu for people across the scales of a neighborhood, a district, a town and even a region.

The economic side of the new technology development remains particularly viable. The development of new applications enhances business productivity and amplifies coordinated methods and synergies. Various problems of contemporary urban living, which smart technology helps to solve, go far beyond commonly recognized insufficient data sets for planning. From traffic jams and inefficient public transportation systems, through unhealthy climate conditions and improper urban environment, perceived lack of safety, inefficient infrastructure and lack of coordination of different urban services; smart tools prove useful in each of the above situations.

DANGERS

The development of new tools requires careful implementation. More and more scientists warn against the disruptive power of technologies. First, progressing privatization and financialization of some services, due to a lack of regulation, may limit their availability. The technology may impede progress if it is implemented naively and without a comprehensive and widely approved vision. While exchange and communication platforms facilitate transactions between people, not all of them are legal. What is more, increases in remote contacts and computer dependence gives way to isolation, furthering societal issues of isolation, loneliness and depression. Increased safety may come with far-reaching surveillance and thus limited freedom, both in physical and digital spaces. Consequently, public space becomes more fragmented with clear divisions into publicly accessible and privately controlled spaces, with limited accessibility and extended control. Even economic growth may not be as sustainable as predicted if systems are characterized by closed architecture, preventing start-ups to develop their ideas. On the other hand, the individual creativity can contribute a lot providing tools which cater to specific needs of individualistic Postmodern society. However, the open and usually bottom-up character of startup applications, while incorporating necessary levels of complexity, may bring the danger of catering to the needs of stockholders and investors at the expense of more deprived groups. The digital divide may thus deepen, which can be further worsen through the replacement of human work by the one of machines.

Further, due to technology driven implementation, development focus may be on certain fields of industry while neglecting other, more urgent activities which may be more complex and more difficult to execute.

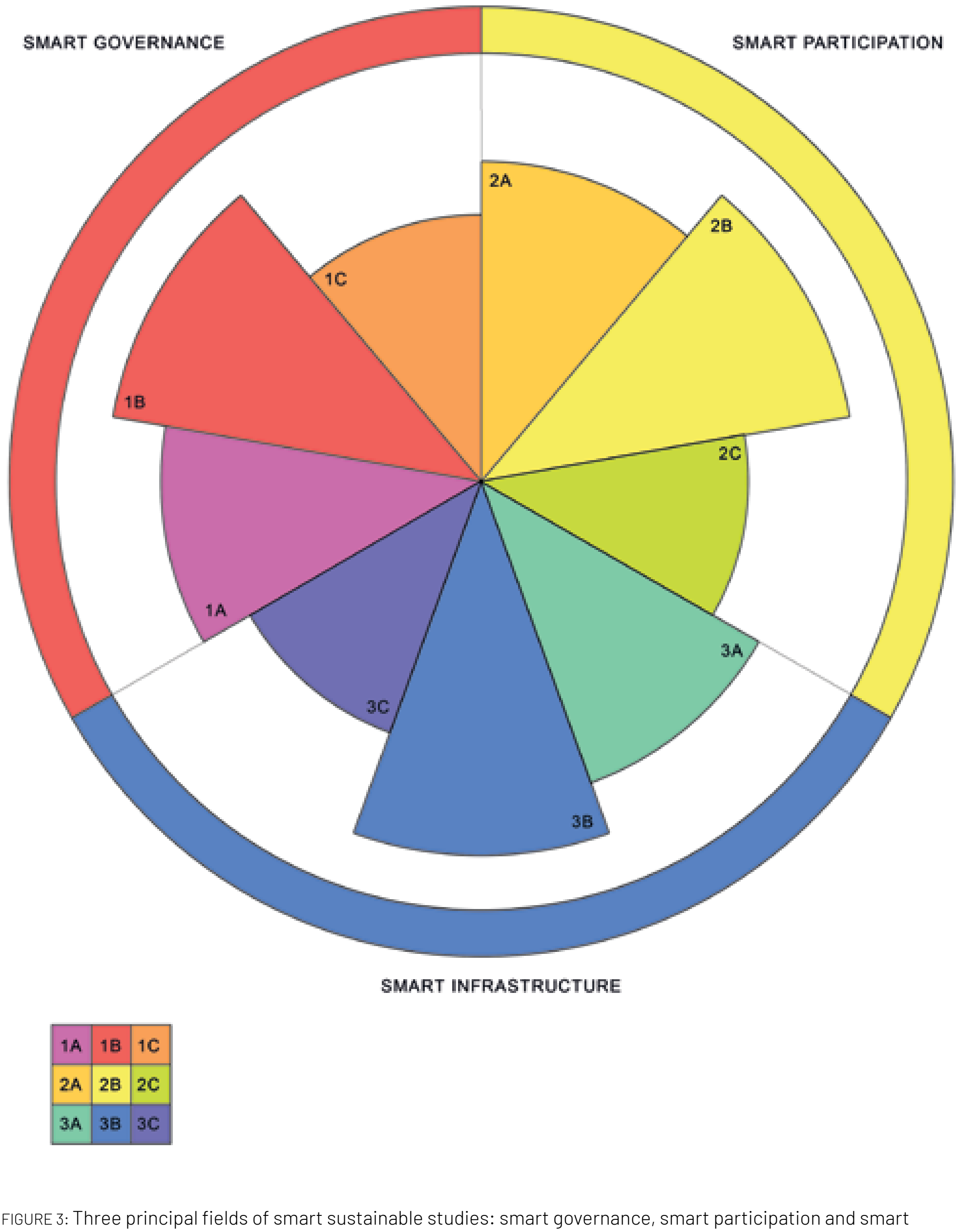
HOW SHOULD SMART TECHNOLOGY BE IMPLEMENTED?

The application of properly integrated new technologies, such as daily satellite imagery, drones, graphic visualization and simulation, big data, powerful algorithms and deep learning, transect-based planning and form-based codes, promise plans for new cities in months and instant planning permits. If achievable, such a change in planning could revolutionize the national/provincial-local legal framework relationship, but at the costs of some safeguards [02]. In addition, the development of focused technological planning support using modelling, digital communication, and the introduction of an ICT based platform, can dramatically change the nature of decision making, from the opposition of governance versus citizenry towards a problem focused paradigm[2].

We as a global community of urban planners should realize that transformations to the profession are unstoppable, and as such we must define the right paths of their implementation by implementing the following. First, the challenge of transforming urban settings needs to be powered by people, with an emphasis on bottom-up processes of collaboration and social inclusion – starting from the planning process. Second, novel laws are needed, which incorporate citizen aspirations, creativity and input. Whereas individual initiatives are usually easier to develop and implement, public sector services satisfy broad needs more efficiently. Thus, while public and private partnership is necessary for smart city development, the responsible implementation requires legal frameworks at various levels of governance and adjusted to local conditions.

GOAL AND METHOD

The integration of the principle of sustainability makes the task at hand more challenging. In their definition, the ITU-T Focus Group explains a smart, sustainable city as *'an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects as well as cultural.'* [3] This statement, which incorporates the classical definition of sustainable development given in the Brundtland Report[4] attempts to link two seemingly contradictory fields. Adopting sustainable, resilient and regeneration principles while using and developing innovative technologies to implement them may prove a daunting challenge. This may mean constraining free technological development to satisfy actual, long-term human needs, imposing complex planning principles and sometimes even giving up sophisticated technological solutions for the sake of common sense and established methods.



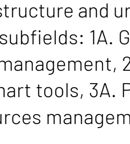


FIGURE 3: Three principal fields of smart sustainable studies: smart governance, smart participation and smart infrastructure and urban services.
Main subfields: 1A. Governance and management practices, 1B. Smart planning and machine learning, 1C. BIG data management, 2A. Crowdsourcing and co-governance, 2B. ICT supported public participation, 2C. Bottom-up smart tools, 3A. Public spaces and augmented reality, 3B. Shared, autonomous mobility, 3C. Energy and resources management

This may as well mean providing solutions which last and reusing resources instead of just producing new tools and delivering new products. This should also consider the long time needed for humans to adopt new ways of satisfying daily requirements and the feedback loop needed to acquire knowledge on the technological impacts on our cultures and health.

The relation of these two principles: technological (and often also, by assumption, economic growth) and the idea of sustainability might prove challenging when balancing public needs and economic considerations. Another set of issues refers to the preservation of the cultural authenticity and vibrancy of the informal sector. This requires enhanced transparency of government actions and open systems, which may undergo collective control through the incorporation of new tools and applications. Integration of planning for sustainability, resilience and regenerations obliges us to adopt universal values, which could then be further shared while developing technological solutions.

In this paper, we review multiple examples of smart, sustainable city implementations and research. To do so, we have defined an initial framework which places each of the examples on the diagram representing main fields of implementation.

The contributions by our respondents pertain to all aspects of urban life and reflect the widespread applications and even broader potential for implementation of technology in urban planning and design, urban management, governance and policy making. The contributions, coming from places all over the world address both general issues and specific practices.

The multiplicity of theoretical contributions and case studies, which include theoretical considerations reflect the complexity of the raising field of science, which deals with the implementation of technology in urban life. In the following section, we briefly reflect on the specific areas of technology applications. Further, the chosen, most representative contributions have been summarized and included in the Appendix.

SMART GOVERNANCE AND PLANNING

GOVERNANCE AND MANAGEMENT PRACTICES

The idea of smart technology challenges the ways how cities are governed and planned [03]. In a recent report conducted on behalf of the European Commission, there is clear commitment amongst European governments to work towards unlashing the full potential of co-creation and collaboration between governmental departments and the public sector, to provide public goods and governmental services. The platform for this new type of collaboration is enabled by vast application of Information and Communication Technology (ICT) tools.

However, to be able to harness the full potential of such tools, integration of infrastructure and technical interoperability is required.

Integration of infrastructures in the city governance represents the process of breaking down information silos in the public administration services and integrating physical, spatial and digital assets (data, applications and services). E-Government and Open Governmental Services (OGS) represent the transition of the traditional public services into open, transparent and collaborative, where governments are responsibly and safely regulating open [public] data access, by making it standardized, inclusive, secure, transparent and easily [digitally] accessible.

The new paradigm shift brings a great need to better understand the relationship between the *'new (digital) forms'* of societal actors, considering the new possibilities due to the availability of the digital interaction footprint in generating deeper insights. However, eliminating the human factor in this *'digital interaction analysis'* does not guarantee unbiased insights. Responsible technology must be supplied to guarantee and protect the democracy of public systems and services. Algorithmic transparency and accountability are deemed as fundamental for accountable and affirmative use of advanced ICT tools. City departments wish to peruse making policies on complete datasets; the process includes establishing fully integrated system of systems for information and resources transparency, and further responsibly opening data towards the private sector.

Goldie illustrates his theoretical considerations giving an example of the Triple Bottom Line Model [02]. It gives no specific guidance to urban planners as to what should be built where or in what form. Thus, an operational sustainability model for city planning can be developed based on automation to a geographical information system which can produce first draft of urban structure plans further finalized by extensive community, peer, political and judicial reviews.

SMART PLANNING IN METROPOLITAN SCALE/ SMART CITY-REGIONS

According to Elliot [04], a successful smart city means using data to inform plan-making with issues ranging from understanding patterns of travel by different social groups to ones ranging from standardizing density levels to those which describe how to protect vulnerable social groups which might be impacted by climate change. The efficient implementation of this sort of solutions at all scales has been made feasible thanks to the widespread utilization of GIS tools. This is reflected, for instance, in the efforts to translate the global issues of growing environmental risk, climate change and the needed radical reduction of greenhouse gas emissions into specific challenges linking smart cities initiatives and strategic planning. For example, the failure to tackle the issues of affordable houses and long car-based commuting with costs of congestion, wasted productivity and air pollution resulted in relatively low productivity of secondary cities creating regional divides between successful and struggling places and mass high-skilled youth migration. The New Urban Agenda clearly states that these issues demand for a coordinated wide scale approach involving entire city-regions and metropolitan areas which would not be achievable without ICT, both applied for data management and analyses and as management and communication tools.

SMART PLANNING AS A SCENARIO-DRIVEN PROCESS

To Itova [03] planning in its broad sense represents organizing the use of space based on assumptions for possible futures, by producing scenario-driven alternative shapes for the urban environments that foster social and economic prosperity, while not endangering adjacent natural habitat. Therefore, bringing comprehensive, intensive and accurate context information to the planning process is central starting point. Additionally, in this era of hyper-connected people and places, technologies can capture, transmit and process information at the speed of light. Smart planning may well refer to the process of harnessing the full potential of available and emerging sensing, data processing and computing technologies, to enhance the inclusion of complete information spectrum for the benefit of supporting the planning and design process. The production of [urban] data via big data and context-aware ecosystems, from which valuable information is extracted for operationalization in management of public spaces and related services is always a situated process, influenced by its temporal and spatial context.

So far, predictive analytics systems find vast application in the social sciences and services related to national and public security [03]. Collectively known as *sentiment analytics,* the methods of *descriptive, predictive* and *prescriptive* analytics attempt to synthetize, analyze and predict possible outcomes, after combining and processing immense amount of historic and near real-time georeferenced raw data, connecting situational and temporal parameters with behavioral patterns. *Sentiment analytics* models population behaviors captured via social and other media platforms, with a goal to predict future trends and anticipated behaviors.

LAND MANAGEMENT

Connecting land-use data and material flows to economic sectors, enables parallel analysis of resource and land intensities related to economic activities. However, the lack of existing empirical studies addressing the question of the spatial distribution of material flows and the implication changes in the metabolic profile of regions for regional land use changes, remains a great challenge. Smart technologies related to distributed computing, Ambient Intelligence (AmI) and Deep Learning (DL) have the potential in addressing this specific challenge. The ***Urban Metabolic Networks*** model [05] trains artificial intelligence (AI) on million(s) anonymized data from various consumption trends, collected by residents from diverse demographics at the level of a mega-city, aiming to spot the earliest signs of pre-defined urban flows anomalies and respond with prompt diagnosis.

[BIG] DATA MANAGEMENT [06]

Recent citywide investments in ICT infrastructures have made data broadly available. As a result, there has been increased interest in the methods and techniques for inferring context knowledge from user data for strategic decision-making purposes. The main analytical and computational processes behind knowledge discovery are data mining and context recognition.

Big data and context information are the basis for the next wave of urban planning and management related to urban sustainability, enabled by deep insights; intelligent decision making; machine learning, statistics and related modelling and prediction methods [06].

'Big data' refers to information assets high in variety, volume, velocity, value and volatility, where processing this heterogeneity, increase, complexity, temporality, unpredictability, availability and application in various domains is beyond the capacity of traditional analytical software. Further, big data is always automatically tagged with temporal and spatial labels by their source- mainly sensors. The following systems are widely used when handling big data:

- Tools- classification; clustering and regression algorithms
- Techniques- machine learning
- Technologies- hadoop; hbase and mongodb

Big data analytics and context-aware computing are two integral parts of ICT that share common core enabling technologies: unobtrusive and ubiquitous sensing technologies and networks, advanced data management and processing techniques and platforms, fast and affordable distributed computing and middleware infrastructures and advanced wireless communication technologies, vastly known as IoT.

PUBLIC PARTICIPATION – SHIFT IN APPROACH

ICT networks are an important social medium in contemporary urban life, enabling active and passive participation in the process of spatial consumption, city management and urban planning/design – such as targeting citizens' awareness or sensing and management of the urban environment [07]. The digital form enables better (and instant) detection of changes, efficient utilization of data and transparency in city processes directly enabling resource efficiency. Information networks support communication increase awareness and enhance cooperation between all levels of government and stakeholders. Three democratic values – legitimacy, effectiveness and justice – are generated through smart government as an application, including bottom-up civil contributions all the while maintain governments' responsibility for large-scale urban interventions.

Urban development, governance and public participation based on the preferred 'open model' still must achieve representative level of interaction between civilians and governments by improving accessibility, flexibility and usability of ICT networks and tools thus improving communicative potential and overcoming a gap between intellectualization and action.

CREATIVE TECHNIQUES FOR CREATIVE ENGAGEMENT [08]

Creative public engagement is key in achieving the Sustainable Development Goal 11 part of the New Urban Agenda. There are many existing public engagement techniques including traditional public hearings, community meetings and various planning workshops. Digital, communication and other tools can be used to support public engagement approach or program.

Stephens and Van Epp [08] quote an example of the successful online collaboration in South Ironbound neighborhood of Newark, New Jersey. Historically was one of the most polluted neighborhoods in the United States, it went through the exemplary process of urban rehabilitation. The Ironbound Community Corporation (ICC) initiated an Environmental Justice Movement through community meetings held at various locations with surveys and public engagement activities which aimed to improve quality of air, water and green space. Over 150 residents, small business owners and neighborhood stakeholders were successfully consulted for the resulting Climate Resilience Action Plan, reflecting their needs and benefits.

PUBLIC PARTICIPATION 2.0 [09]

Recently, the traditional hierarchical relationship adopted in the top-down scenario planning process has evolved towards envisioning methods incorporating bottom-up contributions. Unfortunately, this model has long been challenged by the poor attention to citizen needs coupled with an inadequate opposition to main transformation demands of the most influential stakeholders, the decision makers. Traditional participation process in planning is strongly associated with interest groups, which are a common form of organized citizens, while Transactive Planning assumes continuous and real-time interaction between planners, experts and citizens of all forms.

In terms of planning theory 2.0, planning is a renewed approach to Advocacy Planning where the virtual environment is the collector of interactions. Social scanning via social platforms as a fundamental instrument in collecting ideas, opinions, etc. from citizens can lead from a closed model of decision-making involving governments and representative elected democracy, to an integration of representative democracy and collaborative approaches, enabling decision makers to directly consult citizens before taking a stand.

SOCIAL AS THE NEW SMART [10]

The inclusive, participatory approach has become broadly shared by planning NGOs. The International Federation on Housing and Planning (IFHP) criticize the current smart solutions as they only speak to economic and environmental success criteria, omitting the social aspect. Their approach balances the three pillars of sustainability, using the right tools to capture the social dimension. Failure to capture the social domain will lead to collapse of cities, where citizens will ultimately pay the price. The IFHP "Social Cities" program and tool consist of three steps- collecting and translating data on social indicators in easily understandable diagnosis, co-operation lab for co-creating solutions, and global knowledge-dissemination platform of best practices.

SMART INFRASTRUCTURE

Advocating against the use of technology in urban life would be absurd, what we support instead is technology which endures. Duarte and Firmino[5] point at three essential features for sustainable innovations: they prevail in a given context; they join values of a different character: social, economic, political and scientific; and, they adapt themselves to changing sociotechnical situations. For these reasons we state after [11] that '*Smart means working on how we want to live - not on how we used to live'.*

The unimaginative discussion on physical structures- highways, roads and bridges- should focus on *"intelligence"* opposed to *"smart"*, referring to structures that learn from the environment, adapting to thrive in new conditions and discount *outmoded* parts. Inhabitants are seeking urban amenities and easy commutes giving them freedom to drive less, while younger generations are choosing new modes of shared semi-private or reliable public transport and walkable neighborhoods.

Urban infrastructure investments must support new ways of living: adapt old systems to new users; use fortifications as urban amenities; repurpose roads and sidewalks; favor compact vehicles; make cities greener by increasing presence of parks, trees and urban agriculture; use lighter and less expensive building systems; encourage zoning supporting mixed-use and densification; and utilize water as a transportation mode.

ROLE OF PUBLIC SPACES/ AUGMENTED REALITY/ DESIGNING INFORMATION-RICH STREETSCAPES [12]

Smart city strategic projects and interventions justify the re-emerging role of cities shifting from car-oriented to human-oriented environments, where urban commons are needed to provide suitable settings for direct interpersonal contacts. Information and communication technologies (ICT) have led to new possibilities of accessing information and opportunities of using the street environment as an interface to transfer various types of information context.

Augmented Reality and urban analytics enable new potential layers and urban semantics, which generate novel types of activities replacing the traditional face-to-face (necessary, optional and social) interaction in the public realm, subsequently bringing higher levels of social isolation. Thus, architects and urban planners need new tools to be integrated into urban environments allowing them to access collective information stemming from the shift from personal to online social interaction.

ALTERNATIVE AND RENEWABLE ENERGIES [13]

Smart cities will be integrated and interdependent with alternative and renewable energies. Today, cities require approximately 75% of the world’s energy and produce about 80% of carbon emissions. Smart cities must and will reverse these impacts by becoming both zero-energy and zero-carbon. Eventually advances in energy- and carbon-engineering will enable energy- and carbon-neutral smart cities to become energy producers and carbon removers. Smart city programs will adopt and adapt programs such as the “Living Building Challenge” for urban and metropolitan development scales. Ultimately, cities—which have created most environmental impacts—will also provide the solutions.

For these shifts to occur, alternative and renewable energies must be economically competitive with carbon-based fuels; public and private sectors must implement action plans to support and ultimately require alternative and renewable energies; and, public participation must be combined with education and collaborative decision-making.

Natural renewable energy sources include solar, wind, geothermal, hydro, and oceanic. Mechanical renewable energy sources include biomass and hydrogen. Nuclear energy is currently problematic in regard to safety hazards and waste disposal, but emerging technologies (i.e. Thorium fuel) may make this a much more viable alternative energy source in the future. Smart cities will develop specific energy systems based on the availability of these sources.

Within the next two decades there will likely be several game-changers and black swans. Game-changers are events, ideas, or procedures that effect a significant shift in the current manner of doing or thinking about something. An example of an energy game-changer would be extremely efficient and inexpensive solar power and storage that would not only enable zero-energy and zero-carbon development but have far-ranging implications for urban resiliency and energy independence. Black swans are events that come as a surprise and have major effects. An example of an energy black swan would be a computer virus which disrupted city-wide infrastructure. Energy game-changers and black swans will accompany the technological singularity projected for mid-century. The technological singularity (also, simply, the singularity) is the hypothesis that the invention of artificial superintelligence (ASI) will abruptly trigger runaway technological growth, resulting in unfathomable changes to human civilization. (A.H. Eden)

SHARED MOBILITY, SMART TRANSPORTATION & INFRASTRUCTURE EFFICIENCY/ AUTONOMOUS VEHICLE SYSTEMS [14]

Autonomous transportation will change our urban landscapes and daily lives and ways that are currently unimaginable. Most transit systems already have some levels of autonomy such as airliner autopilots and automatic train operation. These systems are becoming increasingly sophisticated, and many do not require any human intervention to operate safely and efficiently.

The complexity of these multi-modal and inter-modal systems will require smart cities to develop intelligent transportation systems (ITS). One highly visible aspect of this technological shift is the development of autonomous or driverless cars. Smart cities around the world are introducing autonomous cars, taxis, and buses in test programs. Projections are for these vehicles to achieve commercial production within the next decade. Autonomous cars will liberate transportation for many persons unable to drive; they may offer an efficient alternative to car ownership; and they may dramatically reduce the surface area required for streets and parking. They may also increase traffic congestion; create new types of transportation challenges; and exacerbate socio-economic disparities. Smart cities will need to reevaluate their street networks and parking; demographic impacts; and other urban issues in response to potentially radical changes in transportation behavior due to the introduction of autonomous vehicles.

Another autonomous vehicle with enormous potential for smart cities is the unmanned aircraft system or drone. After less than a decade of commercial production, drones are becoming essential technologies for hundreds of commercial applications ranging from precision agriculture to emergency management. Simultaneous with the design of driverless cars, there are several passenger drone prototypes currently in development with some projected for public operation as soon as 2020. Current issues are safety, security, privacy, property rights, and nuisance. As the public becomes more attenuated to the presence of drones, they may ultimately become ubiquitous. Smart cities will need to reimagine their cities to consider airspace and the opportunities and constraints associated with unmanned aerial vehicles.

URBAN METABOLISM, SYSTEM APPROACH/ RESOURCE USAGE OPTIMIZATION

Looking from the perspective of Urban Metabolism, one of the most essential aspects of smart technologies is the optimization of flows of resources. This is specifically valid when considering the environmental impact of human settlements. The systemic analyses of urban flows was started by Wolman, who defined the ‘metabolic requirements of a city’ as ‘all the materials and commodities needed to sustain the city’s inhabitants at home, at work and at play’[6]. In the analysis, he addressed a hypothetical city of a million inhabitants in the USA. It described the flows of food, water and fuel into the city and of sewage, air pollutants and solid waste out of it. Whereas typically UM research has addressed flows of energy, water and materials, contemporary perspective has widened and looks for a broader context of sustainability science[7]. Dijst et al. define UM as a ‘network of heterogeneous flows in cities’[8] and notice a recent increase in such studies. Recent years observe an increasing interest in GHG emissions and, specifically, analyses of CO2 emissions.

The processes taking place in the urban environment vary in their pace of transformations[9]. Wegener[10] and Dijst[11] enriched the initial set of commonly studied topics by adding long-term transformations of land use and building stock and the evolution of transportation systems and infrastructure. Other processes they have considered those human activities which tend to alter more quickly, such as household composition, employment, and rapid circulation of people and goods. Dijst et al.[12] also consider the flows of information and money, both in the context of business and personal lives.

Furthermore, considering the scale of human impact on the environment, Steffen et al[13] argue that the analyses should also cover natural processes and the extent to which they are affected by human-driven activities. These transformations stem from social and demographic conditions and the extent to which they affect lifestyles. Lyons et al.[14] name the following features which, influenced by everyday citizens' behaviors, affect the forms of urban settings: transportation, activities and consumption patterns, residential choices and ICT use. Broto et al.[15] acknowledges the role of patterns of production and consumption, and thus the influence of social processes on circulation and stocks of resources and the ecological environment. The processes which take place in cities are interdependent. For instance, urban design influences modal split and transportation modes, which, in turn, affect demand for space, noise levels and air quality, which further impacts the health of citizens, their lifestyles and personal choices. This complexity gets even greater when incorporating issues of urban resilience[16]. For example, transparency about natural hazards may indirectly impact housing prices and, in the aftermath, the distribution of housing. Urban metabolism models may become useful when building land-use models incorporating ecosystem services[17].

A model of material and energy flows, therefore, would create opportunities to better comprehend and optimize the functioning of an urban system[18]. Thanks to the application of GIS tools, quantitative applications of such systematic analyses in urban planning and design field becomes increasingly feasible[19]. Optimization of urban flows, thanks to their enhanced management, gives the opportunity to significantly reduce the consumption, multi-source, recycle and recover all the resources- this way diminishing the overall urbanization impact. As yet however, there are not many normative applications of urban metabolism studies in urban design and planning.

RESOURCE EFFICIENCY [15]

The world's urban population will nearly double by 2050 and urbanization will become one of the twenty-first century's most fundamental trends. Populations, economic activities, social and cultural interactions, as well as environmental and humanitarian impacts, are increasingly concentrated in cities. This poses massive sustainability challenges regarding housing, infrastructure, services, food security, health, education, decent jobs, safety and natural resources, among others.

The New Urban Agenda presents a paradigm shift based on the science of cities. It underlines the relations between urbanization and job creation, livelihood opportunities, and improved quality of life, which every urban renewal policy and strategy should include.

Cities concentrate global economic production and consumption, producing some 80% of global GDP. Although cities occupy only 2% of the world's land surface, they consume 75% of natural resources, produce 50% of global waste and account for 60-80% of GHG emissions. The rapid growth of cities has lead to the scarcity of resources. In some cases the situation requires immediate actions as already 780 million people lack access to drinking water and by 2030 global demand for water will supposedly grow 50%[20].

The New Urban Agenda emphasizes this theme promoting resource efficiency and sustainable consumption and production in cities. Whereas the energy demand is expected to increase by 40%, proper urban planning could reduce energy consumption in urban settlements by 50%. There are many factors which influence the usage of energy and resources: the genre of business activities, the configuration and form of structures people inhabit, climatic and geographic conditions, type and way of use of infrastructure. Not least important are human everyday behaviors and the impact of citizens routines and interactions on energy and resource consumption. The critical challenge is changing the flows of resources and energy to optimize their exchange and use in the city.

Vettorato [15] states that the climate change is an overheating phenomenon. Earth's temperature depends on how much sunlight the land, oceans, and atmosphere absorb, and how much heat the planet radiates back to space. The enormous amounts of energy involved in these processes can be re-used [15]. For example, in the US in 2016 alone, 66.4 Quadrillion of BTUs were classified as rejected energy[21]. Assuming a BTU average cost of 20$, the sum of $1,328,000,000,000 was wasted that year in the US only. Cities use energy in an inefficient way, the same level of services may be provided with 50% energy.

Vettorato [15] proposes to optimize the use of energy and resources and this way tackle the scarcity through the intelligent use of space (public and private) and technology, mobilizing, involving and empowering key stakeholders. The proposed strategy is based on the concept of co-benefits 'socio-economic and environmental positive effects related to the execution of a project, exceeding the primary goal'[22]. The overlap of several goals achieved with the same amount of energy or resources makes the reduction and re-use possible.

FIGURE 4: Spatial distribution of all the case studies and individual contributors to the current paper

CASE STUDIES

The case studies below highlight the above ideas with six examples of various scales and context. They start at the level of the whole country as demonstrated by the Rwanda's example of Smart City Rwanda Master Plan supported by UN-Habitat. This initiative, which aims to improve the quality of life using technology, may be further exploited in other African and Asian countries. As further examples show, the metropolitan areas are especially prone to become test fields for smart cities. The case studies address problems of high densities in megacities, looking for transit-oriented infill solutions as in the project described by Now Institute. Two other case studies address Surat and Delhi in India; the first one demonstrating successful application of smart infrastructure development for the benefit of citizens health, the second revisiting challenges faced by Indian capital city due to the increase of local heat island. Improvements of infrastructure and smart governance are the tools implemented to slow down decay and rehabilitate the deterioration town of Port Louis in Mauritius. The last case study addresses the participatory approach using 3D IT communication platform in Schiedam, the Netherlands.

Javier Torner, UN Habitat: **Urban Planning and innovation to capture the potential of new technologies and processes (Rwanda)**

UN-Habitat supports the Rwandese government in implementing the Smart City Rwanda Master Plan, promoting integration of technology as a critical tool in sustainable urban development to enhance inhabitants' quality of life. The tool is designed to support nation-wide level of smart city developments, guiding Mayors and city managers in further creating local smart city strategies and masterplans.

Subsequently, the 27 ongoing initiatives are organized in three pillars- smart governance and planning; smart efficient services and utilities; and localized innovation for social and economic development. The initiative of using technology as a means to improve quality of life- a citizen-based approach to innovation and technology- has the potential to be scaled in many African and Asian countries including the ongoing discussion in Nigeria and Myanmar.

Valerie Leblond and Simon Flack, Now Institute: **Human Scale Density**

The Now Institute is an international non-profit organization dedicated to understanding and improving the urban environments, led by the Pritzker Prize winner Thom Mayne and embedded within the IDEAS research platform of UCLA Architecture and Urban Design.

In the limited space for world urban population of accelerated growth, new infrastructure for housing, sustainable mass transit, agriculture and energy must be secured through enabling novel ways for technology and services to keep society breathing to interface with one another in close proximity.

Cities like Mexico City and Beijing are already un-livable regarding transit and proximity to nodes solves already many of the issues surrounding density of old and the coordination of both services and transit. Thus, key to the Now Institute research approach is strategic allocation of density to more than one homogeneous and ever-expanding level of a city, applying this methodology to the city of Los Angeles (CA). One of the pilot projects of re-envisioning of L.A.'s iconic Wilshire Boulevard proposes interpretive transit-oriented, high-density infill strategies, accommodating the city's fragmentation, heterogeneity and idiosyncrasies embedded within multi-layer zones of culture, healthcare and businesses.

Amit Chatterjee, School of Planning and Architecture (SPA), Bhopal: Smart City Mission in Surat, India

Surat is a rapidly growing city housing population size of 4.4 million in 2011 which before 1990s, due to the rapid migration influx shortly after was known for reduced hygiene, facing several management problems and an outbreak of pneumonic plague resulting with large loss of human life.

This urged the municipal government to transform Surat to clean livable city, pioneering in implementing sewage treatment plants (STPs) with biogas energy (methane recovery). The currently running supervisory control and data acquisition (SCADA) system has the entire workflow- equipment, gates, aerators, blowers, pumps etc.- available at single online control place.

Supported by United Nations Development Programme (UNDP) funding, the municipal government worked hand in hand with central and state government and multiple other international agencies, national level technical/scientific institution, private sector partners to prepare comprehensive sewerage network master plan.

The Smart City Mission launched by the Indian Government in 2015 aims to improve public services and citizen interface in 100 cities via pan-city and area projects including integrated traffic and mobility administration center, smart city center for delivery of civic services, common city payment system, citizen interface mobile application etc.

Mahak Agrawal: Climate Resilient Urban Development Strategies for a megacity: A Case of NCT of Delhi

Delhi, India has been one of the mega cities which has been at the top of the emission charts for over two decades and continues to grow beyond its carrying capacity. The city experienced population expansion from approximately four hundred thousand in 1901 to nearly eighteen million in 2016, the growth being accommodated in 685 km² coverage area (or 130 persons/ha) in 1991, to 1200 km² (or 190 person/ha) in 2011, while engulfing its rural counterparts and declining the annual agriculture production by 0.5%.

This physical expansion corresponds with loss of heat sinks at annual rate of 1.4 per cent and increased in built up area by 1.4% resulting with an increase in air and surface temperature by 0.3%. From 1901 the annual average temperature in the city has increased by 1.4°C, out of which 0.93°C spiked in the past three decades alone. Both trends are further interlinked with the loss of the urban environment and the three together form a vicious cycle, whereby urbanization is leading to loss or destruction of environmental resources and aggravating climate variability.

The research develops a correlation model to study the impact of urbanization and urban planning on the climate variability and environment for a megacity of Delhi, and conclusively develops three alternative models for future development, showing that the city has entered into a stage where there is no coming back but the rate of deterioration can be slowed if resilient strategies are adopted and prioritized at the earliest.

Zaheer Allam: **Redefining the smart city: culture, governance and metabolism (case study of Port Louis, Mauritius)**

Tools for enhancing productivity and interconnectivity by big data and real-time processing are further expanding the role of economies in the concept of smart cities, while imposing danger of technocratic governance and omitting key environmental issues- loss of biodiversity, urban sprawl and increased vehicular transportation.

Unhealthy environment is further constructed as new towns applying cutting-edge infrastructures only attract upper middle-class professionals, anomaly which can be overcome by showcasing existing cities using smart concept.

Smart Mauritius Initiative in 2015 launched a framework for new Smart Cities leaving Port Louis to slow urban and economic decay, due to lack of available concepts for smartening existing city. The conducted research resulted with theoretical model linking culture, governance and metabolism in a *National Urban Regeneration Scheme* as a resulting framework to sustainably smartening and modelling economic qualification of adoption of the existing city.

Islam Bouzguenda, Universitat de Girona: **Perspectives on Citizen Participation for the Digital Age; Urban Development Based Research & Case Study**

The new model of the smart city developed with Schiedam city includes citizens' participation as sensing nodes. Three stages of the participation tool were conceptually designed to empower successful citizen participation, which by urbanist and technology expert Antony Townsend, connects people more and brings up new potentials of using data to help understand complex problems better. While traditional ways of civic engagement are no longer appealing to some groups of citizens, widespread technologies in smart cities should empower them to interact with their city and participate in its decision-making processes.

Modulating participation as a leisure activity-- making co-creation enjoyable and interesting, any time available to citizens; improving participation in decision making by empowering the usage of technological and social tools available in the city and mixed reality technologies as a part of future participatory urban planning; and influencing participation with 3D interactive design tools and context visualization-- could help attract more civil engagement.

CONCLUSIONS

The current paper represents a concerted effort of several experts in the field of smart sustainable planning. It provides an attempt to systematize the complexity and richness of this domain. After an introduction containing a review of the state of arts, its challenges and dangers, we look at the three main pillars of the technology application in the planning discipline which are:

- Smart governance and (big) data management,
- Participatory planning and the potential to use the ict as communication to shift the planning focus towards problem solving and bottom-up approach,
- And infrastructure perceived as a backbone for development and opportunity to improve and optimize resources and energy efficiency.

After a review of theoretical approaches, we illustrate them with six innovative case studies coming from the urban design and planning practice.

Neither the catalogue of theoretical approaches nor the list of examples are closed. The classification used here is of an ordering character but in reality each single application joins and uses various technical tools, depending on the case studies' requirements. The current catalogue of methods and case studies just opens a topic, which with time and the development of both research and planning practice will deliver more and more tools. What needs to be underlined however is that to achieve sustainable community development, the technology needs to serve needs of a given society and the pace of development should be adjusted to enable harmonious progress of all the interrelated fields, providing framework for successful cultural, environmental and societal development.

ENDNOTES

1 This article is a compilation of contributions from some of the participants of these events and organizations.

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APPENDIX

Theoretical Contributions

[01] **Introduction: Smart City** (Nicole Wirz Schneider, MAS Raumplanung ETH REG A)

Smart Governance and Planning

[02] **Smart Sustainable Cities** (Stephen Goldie)

[03] **Smart Governance and Smart Planning** (Irena Itova, UniverCities)

[04] **Smart City-Regions** (Trudi Elliott, Royal Town Planning Institute)

[05] **Mining Urban Sustainability/ Land Management** (Irena Itova, UniverCities)

[06] **[big] Data management** (Irena Itova, UniverCities)

Public participation

[07] **ICT and Public Participation/Smart Governance** (Aleksandra Stupar, University of Belgrade)

[08] **Creative techniques for creative engagement** (Ric Stephens, President of ISOCARP and Tim Van Epp)

[09] **Public Participation 2.0** (Beniamino Murgante, University of Basilicata)

[10] **Social is the new Smart** (Morten Nielsen, IFHP)

Smart infrastructure

[11] **Smart means working on how we want to live- not on how we used to live** (Thomas Vonier)

[12] **Designing information-rich streetscapes** (Małgorzata Hanzl, ISOCARP Vice President)

[13] **Alternative and Renewable Energies** (Ric Stephens, President of ISOCARP)

[14] **Shared mobility, smart transportation & infrastructure efficiency/ Autonomous Vehicle Systems** (Ric Stephens, President of ISOCARP)

[15] **Resource efficiency** (Daniele Vettorato, Vice President ISOCARP)

BOOK REVIEW

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GERD ALBERS AWARD BOOK REVIEW
BY AWAIS PIRACHA

THE HOUSE THAT JACK BUILT: JACK MUNDEY, GREEN BANS HERO

BY JIM COLMAN

(NewSouth Publishing, 343 pages, $30 Amazon.com)
This book was awarded the ISOCARP Gerd Albers in 2017

Very few outside Australia would know about the Green Bans of early 1970s in Sydney. Even in Australia their memory is fading. Not many among young Australians would know about them today. The bans were so imbued with romantic and practical vision and so momentous in their outcomes, they ought not to be forgotten. James Colman's book is timely as it aids in keeping that memory alive and vivid.

The book tells the story of the 1960s and 70s when Australia wanted to break from its non-progressive past and modernize both culturally and physically. The physical modernization however, unfortunately, was interpreted as wholesale demolition of medium rise historic sandstone and brick buildings and their replacement with drab, soulless and monstrous sky scrapers.

Historic buildings in the area of Rocks, on the western shore of the Sydney Cove in the idyllic and world-famous Sydney Harbour, were earmarked for demolition and replacement with tall towers. The planning regime at that time was in its initial development stage and hence was weak. The community of local residents living in the Rocks were not influential. The developers and their politician backers were almighty powerful. There was no way the local community was going to be able to stop the demolitions.

The beautiful heritage buildings were however saved by a construction labour union under Jack Mundie's leadership. The union members refused to work on demolition of old buildings and construction of the tall towers. The union took up the cause of protecting the built and the natural environment. Their protests and refusals were not taken lightly by the authorities. They were manhandled. Jack Mundie was even arrested.

The outcome of Jack's actions is beautiful. Rocks is a trendy tourist attraction today. It is a lively place for residents and local, national, and international visitors. It has world famous restaurants and bustling street markets. Today a visit to Sydney is incomplete without a visit to the Rocks. Those who do not know this story are surprised to learn that once someone even thought about demolishing historic buildings of this area.

While maligned at the time of the bans, Jack was acknowledged and even decorated by later day authorities. In subsequent years he was appointed to key positions with planning and heritage agencies. He was awarded honorary degrees by prestigious universities. He inspired environmental and heritage protection movements in other countries. His influence left a legacy of heritage protection primarily in the UK.

The book reminds us that in today's Sydney Jack Mundie is needed again. This time it is not to protect the beautiful built environment of the eastern Sydney, but to protect the West and Southwestern poor half of the city that is under onslaught by poor quality high density development. Today the communities in the poor half of the city are unable to resist this attack.

It is a tale of two cities in metro Sydney today, where community engagement in planning and planning outcomes plays out diametrically differently in the affluent East (NIMBY-Land) than in the poor West (Bogan -Land). Today, among the New South Wales planning apparatus, the community engagement philosophy for Sydney Metropolitan seems to be "NIMBY-Land is too hard - dump it on BOGAN-Land - they will not even notice it". In Sydney today, affluent communities craftily use their connectedness with echelons of power and influence and mastery of digital social media technologies to stymie even the most reasonable developments in their areas while the poor are unable to voice opposition even to the most outrageous in their areas.

Western Sydney is faced by multiple challenges. It lags Eastern Sydney in income, jobs, urban amenities and public transport. Because of the "convenient planning decisions" taken over time, West and southwestern Sydney are already denser than many affluent parts of the city closer to the CBD. That trend continues. The rich of the East and the North are successful in pursuing entrenchment of privilege by keeping their leafy suburbs with large backyards, ignoring the Metropolitan's need to increase density closer to city first.

Even though Western Sydney's population is growing fast, its economy, reliant on manufacturing, is in relative decline. Therefore, Western Sydney residents are faced with a growing jobs deficit. Many Western Sydney residents need to travel to Eastern Sydney to access jobs. As Western Sydney has very little public transport infrastructure, its residents rely on cars for daily commute to East. As a result, Western Sydney faces the increasing level of traffic congestion. Traffic congestion results in economic loss, air pollution, health problems, less time available to spend with family.

To arrest the progress of this tale of two cities – east and north basking in their leafy glory and west and south suffering in their crowded and polluted misery, people with Jack Mundie's vision and courage are desperately needed. James Colman's books reminds us what could be achieved in past and what could be possible for (Western Sydney) in the future.

ENDNOTE

1 Australian slang for a person whose speech, clothing, or attitude or behaviour are considered unrefined or unsophisticated. Wikipedia

Dr. Awais Piracha is a Sydney-based researcher and trainer in the areas of sustainable urban development and use of spatial analysis/techniques in land use and transport planning. Dr. Piracha was trained as a civil/environmental engineer as well as a town planner. He has served at University of Western Sydney as an urban planning academic since 2003.

LIST OF CONTRIBUTORS

SEQUENCE IN ALPHABETICAL ORDER BY SURNAME

ALLEN, JIMMY

Jimmy Allen is an environmental planner and conservation biologist, and is based in Vancouver, British Columbia. He has a Masters in Planning from Dalhousie University and worked previously as an engineer and biologist in the forest industry. His current projects focus on environmental assessment and integrating environmental values and green infrastructure into urban and rural development to help build healthier, more resilient communities. Over the past 25 years, he has worked in both the public and private sector across Canada on projects for government, First Nations, industry, developers and non-profit organizations.

ANDRESEN, INGER

Inger Andresen is a professor in Integrated Energy Design and teaches within the international MSc Program Sustainable Architecture. She is also leading continuing education courses on Zero Emission Buildings. Inger is focusing on developing concepts and solutions for zero emission buildings and plus energy houses. Her main research interest is to develop effective energy solutions that are integral parts of the building design and that supports the realisation of sustainable buildings and good architecture. Her focus is not only on energy efficiency and low carbon footprint, but also on solutions that perform well with respect to indoor and outdoor environment, economics and social aspects. Inger is working package leader for working package 6 "Pilot projects and Living Labs" at the the Research Centre on Zero Emission Neighbourhoods (ZEN) in Smart Cities.

ARORA, AMARINDER

Amarinder Arora is an architect who is fascinated by cities at large, and engages with them through multiple lenses. He has always been motivated to work in the Social Development sector- actively exploring different ways to make a city more inclusive. Amarinder enjoys writing and creating content via mixed media, and he is particularly passionate about performance and visual arts. He strives to bring this creativity to all the projects he engages in.

BAER, DANIELA

Daniela Baer is an economic geographer who works in the field of urban development. Her PhD was about cities in transition and how unused sites could be re-used with services. Besides academia she worked as a consultant for cities and municipalities and as a neighbourhood manager in a Business Improvement district (BID) in Germany. As researcher at SINTEF she is currently working at the Centre for Zero Emission Neighbourhoods in Smart Cities.

BARDAL, KJERSTI GRANÅS

Kjersti Granås Bardal has a Master in Economics and Business Administration from NTNU, Trondheim, Norway, and a PhD in Transport Economics from Nord University, Bodø, Norway. Her field of expertise is within cost- benefit analysis, management accounting and project governance within the context of transport and logistics. She has been working with topics related to the impact of adverse weather and climate change on the transport system and economic impact assessment of various transport measures. Bardal is currently positioned as researcher and head of the Entrepreneurship research group at Nordland Research Institute. The research group conduct research within the topics: innovation, regional development, tourism and marine industry.

BATISTA, LUÍSA

Environment in the Faculty of Engineering of University of Porto, Portugal (CITTA / FEUP). Starting her career in the field of sociology, she later earned her master's and post doctorate in the field of urban planning. Currently, she is working on the research project - Metabolic Impact Assessment (MIA): from theory to practice, where she is studying the integration of metabolic impact assessment tool in the Strategic Environmental Assessment, which can be utilized and applied for urban development,strategic plans and policies. The research intends to prove and underscore the potential of an impact assessment tool such as MIA in the implementation of local climate change mitigation strategies, formulation of alternatinves that can guide decision making exercise and ultimately narrow down to the alternative and strategies which have exhibit positive externalities in the metabolic balance of cities.

BAY-LARSEN, INGRID

Ingrid Bay-Larsen (PhD) is currently Research Director in "Environment and society" at Nordland Research Institute. Her experience reflects a broad interest in sustainable development of northern regions and coastal communities. Throughout her career, she has been involved in projects focusing on spatial management, preservation of biodiversity and ecosystem services, as well as adaptation to climate change in both agriculture, aquaculture and extractive industries. This also includes the co-production of science and policy, and how values, ethics, knowledge systems and environmental risks are perceived and institutionalized in environmental policies and planning. Bay-Larsen has experience from US, Brazil, Russia and several other European countries. Current project portfolio involves upscaling of algae cultivation along the Norwegian coast, reduction of marine litter from fishing industry, circular bioeconomy and smart city, including rurban developments. She holds a genuine interest in inter-disciplinary perspectives and bringing science into the wider society.

BEARS, HEATHER

Dr. Heather Bears, owner of Zoetica, is a highly resourceful environmental specialist with over 20 years of experience in applied sciences, biology and environmental consulting, working for federal government agencies, First Nations, and private clients across Canada. Dr. Bears has amassed a vast depth and breadth of experience in wildlife and fish biology, habitat conservation, environmental assessment, and technical reviews. Dr. Bears has successfully overseen hundreds of large and small environmental consulting projects. She is well-versed in best management practices in environmental planning, mitigation, management and has a demonstrated history of integrating environmental information into management plans. She has also completed many environmental mapping projects including environmental sensitivity mapping and creating heat maps for various environmental values.

BRADBURY, MATTHEW

Matthew Bradbury is Associate Professor in the Landscape Architecture programme at the Department of Landscape Architecture, UNITEC, New Zealand. Matthew has carried out important research into a new urban design model through the development of a methodology that combines both landscape analysis and city design. The most recent research has been on the application of this model to the design of the new waterfront. Matthew has given papers and presentations of his work at several universities and international conferences, including the Harvard GSD. Matthew is director of the Masters of Landscape Architecture / Architecture by Project programme.

BUNSHA, DIONNE

Dionne Bunsha is project coordinator for the Lower Fraser Fisheries Alliance's Climate Adapt project and Aboriginal Knowledge project. She has a Masters in Resource and Environmental Management from Simon Fraser University and a M.Sc. in Development Studies from the London School of Economics and Political Science. Dionne also worked as an environmental journalist in India from 1994 to 2008.

BYRD, HUGH

Hugh Byrd is a Professor of Architecture in Faculty of Art Architecture and Design. He is also an adjunct Professor at Architecture Pathway, Unitec, New Zealand. Hugh obtained a PhD in 1981 and became a registered architect in the UK in 1983. Since then he has balanced a career in both architectural practice and academia in Malaysia, New Zealand and the UK. After teaching and researching at several universities in the UK, Hugh became Professor at the Universiti Sains Malaysia, and then moved on the University of Auckland before taking up the Chair at Lincoln. Hugh's research interests are in the future form of buildings and cities around the world as we enter an era characterised by resource depletion and climate change.

CAO, YUJIE

Yujie Cao graduated as a Master in Urban Planning and Design from Tongji University. And then she works in Wuhan Land Use and Urban Spatial Planning Research Center (WLSP) .She is also a State registered city planner and has involved in many projects about urban development of Wuhan. In her career in WLSP, She and her teams got national prizes on many projects. In Wuhan East Lake Greenway Project, she works as one of the persons chiefly in charge.´

CLARK, JOSEPHINE

Josephine Clark is a Regional Planner with Environment Department at Metro Vancouver – a federation of 21 municipalities, one Electoral Area and one Treaty First Nation that collaboratively plans for and delivers regional-scale services. As a professional biologist and GIS specialist, her work focuses on environmental planning initiatives to tackle complex ecological challenges that cross jurisdictional boundaries across the region. Current projects include mapping sensitive ecosystems, developing ecological health indicators, and quantifying ecosystem services.

EHLRICH, DANIELE

Daniele Ehrlich received the B.S. degree in forestry in 1984 from the University of Padova, Italy, and the Ph.D. degree in 1992 from the University of California at Santa Barbara.
He is a senior staff member of the Joint Research Centre of the European Commission, based in Ispra, Italy. He has over 20 years of experience in remote sensing and GIS applied to a variety of disciplines including crop area estimation, tropical forest mapping, crisis management with focus on damage assessment and humanitarian assistance. His current research focuses on quantifying the extent and the dynamics of settlements using high-resolution satellite imagery. He uses the derived settlement layers for a systematic analysis of the global built-up environment, for population estimations and for generating physical exposure databases for global disaster risk assessments.

FERRARIO, MARCO

Marco Ferrario is the co-founder of mHS CITY LAB. An architect by training, Marco has a mind for creating workable solutions. His idea of creating mobile platforms to provide access to construction knowledge at scale is borne of his passion for elegant solutions that marry useful technology with valuable social outcomes. Marco has not only played hands-on project implementation roles, but also advocacy and advisory roles that have helped promote a multidisciplinary approach to urban inclusion. He has worked as consultant for the World Bank and Habitat for Humanity International.

FLORCZYK, ANETA J.

Aneta Jadwiga Florczyk received the M.Sc. degree from the Technical University of Czestochowa, Czestochowa, Poland, and the Ph.D. degree from the University of Zaragoza, Zaragoza, Spain, in 2012, both in computer science. She contributed to the development of Spanish SDIs through the collaboration with the Advanced Information Systems Laboratory (IAAA), Informatics and Systems Engineering Department, University of Zaragoza. Since 2013, she has been working as a Researcher with the Joint Research Centre, European Commission, Ispra, Italy, where she has supported the production of the GHSL data and derived products. Her research interests include remote sensing, vgi application, statistics, big data management and processing systems.

FOTHERINGHAM, DOUG

Doug Fotheringham is an innovative urban and regional planner with approximately 15 years' experience within the field of local government planning. A member of the Royal Town Planning Institute, his qualifications include a Batchelor of Science in Rural Resource Management from the University of Wales, Aberystwyth and a Postgraduate Diploma in planning from Edinburgh's Heriot-Watt University. Doug is from Scotland and started his career as a planning officer on the Isle of Skye before moving to Australia just over 10 years ago, where he has worked for the City of Launceston, and for the towns of Alice Springs, Esperance and Denmark. He also spent 3½ years as the Manager of Planning for the Shire of Irwin in Western Australia, where he initiated and completed several planning projects including a Green Infrastructure Strategy, a Coastal Hazard Risk Management and Adaptation Plan, a Local Planning Strategy, an Industrial Strategy and the Dongara Town Centre Placemaking Project. He is passionate about cool planning, green infrastructure and placemaking. Having worked on numerous strategic planning projects at both the local and regional level, he has a good understanding of policymaking and implementation. Doug believes that place-based strategies can be used to help governments develop and coordinate their policies so that they deliver their services in efficient ways and accurately target their resources where needed most. He also believes that engaging with communities and creating strategic partnerships are the keys to developing effective place-based strategies.

GUPTA, PANKAJ VIR

Pankaj Vir Gupta is Professor of Architecture at the University of Virginia and co-Director of the Yamuna River Project, the first pan-university grand challenge project at the University. With a Bachelor of Science in Architecture from the University of Virginia (1993), and a Master of Architecture from the Graduate School of Architecture at Yale University (1997), Gupta practices as founder principal Vir Mueller Architects in New Delhi since 2003. Gupta is a registered architect, licensed to practice in the U.S.A., and a member of the Council of Architecture in India. He has received awards from the American Institute of Architects, the Foundation for World Education, the George Nakashima Foundation for Peace, the Graham Foundation for Advanced Studies in the Fine Arts and the Fritz-Höger Award for Excellence in Brick Architecture.

GUSTAVSEN, ARILD

Arild Gustavsen holds a MSc degree in environmental physics (1996) and a PhD degree in building physics (2001). He has worked as an associate professor (2001-2006) and full professor (2007-) at NTNU (teaching building physics and energy use in buildings), as a senior research scientist (2006-2008) at SINTEF Building and Infrastructure (on various projects for the building industry) and visiting researcher at Lawrence Berkeley National Laboratory in 1999 and 2006 (working on experimental and numerical characterization of fenestration systems). Research interests include heat, air and moisture transfer in building envelope systems, application of new materials in building assemblies, and energy use in new and existing buildings and neighbourhoods. Arild is director of the Research Centre on Zero Emission Neighbourhoods (ZEN) in Smart Cities and professor in building physics at Department of Architectural Design, History and Technology at the Norwegian University of Science and Technology (NTNU).

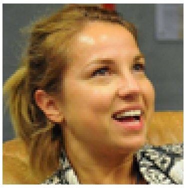
HUYBRECHTS, ERIC

Eric Huybrechts is a senior Architect and Regional/Urban Planner, member of ISOCARP (France representative) and Icomos, Officer in the royal order of Sahametrey (Kingdom of Cambodia). He is in charge of the International and European affairs for the Regional planning Agency of Paris Region (www.iau-idf.fr). He has developed a large experience in the field of Urban and Regional Planning, including Climate change, as expert and team leader on Algiers, Beirut, Cairo, Ethiopia, Istanbul, Mongolia, Mumbai, Paris/ile-de-France region, Phnom Penh, Rio de Janeiro, Saudi Arabia, Tripoli-Libya. He has prepared projects at local level, sub metropolitan, metropolitan, regional and national scales. He represent IAU-IdF to the UNESCO, the World Urban Campaign of UN-Habitat, Climate Chance (in charge of Territorial planning alliance) and the global network of Metropolitan and Territorial planning agencies (MTPA). He manages decentralized cooperation projects with Beirut, Abidjan and Beijing. He has also an academic experience as a scientific researcher and as a lecturer in several universities in France and abroad, mainly on Planning in the Global South.

IÑAKI, ALDAY

Iñaki Alday joined the University of Virginia as Chair of the Department of Architecture in 2011. Since 2016, he has been working as the Director of the Yamuna River Project, the first pan-university grand challenge project at the University of Virginia. The Yamuna River Project is a long-term, inter-disciplinary research program whose objective is to revitalize the ecology of the Yamuna River in the Delhi area. Iñaki Alday and Pankaj Vir Gupta-Professor of Architecture and Principal, Vir Mueller Architects, Delhi initiated the project in 2013. In academia as well as design practice of architecture, landscape architecture, and urbanism, Iñaki Alday promotes a new attitude in front of the urgent challenges on the transformation of our environment. He underscores role of architecture and architects, the interdisciplinary work and integration of scales, the new non-traditional programs as hybrid infrastructures, or the social and environmental ethics as some of the challenges they need to face with a global vision.

ITOVA, IRENA



Irena Itova (MSc, BSc) is the co-founder of UniverCities. She is also a PhD researcher in technology-led innovation supporting sustainable urbanism, with the University of Westminster. She is educated architectural technologist and project manager, with over 10 years of professional and academic experience as an architect and urban planner, within the public and private sector.

She works with research and innovation oriented projects, connecting academic research and practical implementation. The projects implement high degree of innovative (technological and digital transformation) practices over the living and built environment. She studies the versatile and dynamic influence of technology (digital economy and hyper-connected society) over the modern urban environment. She conducts analyses of the societal impact that the pervasive presence of technology brings in modern cities and metropolises. Her professional efforts are dedicated in steering this influence towards positive societal change. She strongly believes that innovative and disruptive phenomena, creating eminent shift in the economy and society at large, can be used to support more efficient and sustainable cities, organized and governed with a human-centric approach.

Her research and practical work relates to human-centred digital transformation of the built environment, supporting sustainable urbanism, while creating healthy and happy future cities for people.

KANG, JINGJING

Jingjing Kang is a senior planner of Wuhan Land Use and Urban Spatial Planning Research Center. She has 10 years working experience in the field of urban planning and also worked in Xiamen Urban Planning and Design Institute for 3 years. As a project manager, she contribue a lot to the Urban Design for Sino-French Wuhan Ecological Demonstration City, Wuhan Moon Lake and Guibei Area.

KETLAODIRELANG, EMMANUEL LETEBEL

Ketlaodirelang Emmanuel Letebele is an urban planner, working at eThekwini Municipality, Strategic Spatial Planning. He holds Master's degree in Town and Regional Planning from the University of KwaZulu Natal. He also has several international work engagements including-study tour and workshop in Bremen in September 2013, participant at the International Network Meeting of the Municipal Climate Partnership during the COP 23 UN Climate Change Conference. Bonn, Germany in November 2017 and attendant of the session on Municipalities at COP 23: Climate Summit of Local and Regional Leaders. He has also represented eThekwini Municipality at the International Dialogue on Climate Proof Urban Development: Workshop: Integrated Urban Development For Climate Responsive Cities in September 2017, Santiago, Chile; and at the 53rd ISOCARP Congress in October 2017 Portland, Oregon, USA.

LEFRANÇOIS, CAMILLE

Camille is an urban planner and GIS specialist with Diamond Head, an environmental consulting firm in Vancouver, Canada. She works with local governments to support them in the development, implementation and evaluation of environmental policies and regulation in particular for urban forests, climate change mitigation and adaptation and environmentally sensitive areas.

LINDELØV, BJARNE

Bjarne Lindeløv is an experienced researcher within topics related to regional development and innovation in private and public sector. In the last decade he has developed a specific focus on circular economy of green industrial and smart city development. Waste management, reuse of waste to new products or to energy, energy efficiency and renewable energy have been highlighted in his research and he has participated in several European projects like Solarok and Elighthouse. His contribution to this article is based on the activity ongoing in the latter project.

LOIBL, WOLFGANG

Wolfgang Loibl holds a MSc and PhD degrees in Geography and Regional Planning. After being employed as spatial planner for 5 years he has been working for over 30 years at AIT- Austrian Institute of Technology- now as Senior Scientist and Deputy Head of the "Sustainable Buildings and Cities" Unit. For more than 20 years he has been teaching Spatial Modelling and Systems Analysis at the University of Vienna, University of Graz and the Technical University Vienna. He is engaged as project-leader in various national and international projects, dealing with regional development and infrastructure planning, climate modelling and adaptation advice, monitoring, statistical analysis and policy assessment and also smart city projects and discourse.

LUNDBERG, AASE KRISTINE

Dr. Aase Kristine Lundberg is a Senior Researcher at Nordland Research Institute. She holds a M.Sc in Human Geography from the University of Oslo (2009), with a specialization in urban geography, and an interdisciplinary PhD in Societal Development and Planning from the Department of Urban and Regional Planning at the Norwegian University of Life Sciences (2017). Her research interest covers public participation, legitimacy and recognition of conflicts and she works across rural and urban contexts. In her PhD dissertation, she explored how legitimacy was constructed and challenged in Norwegian conservation planning. This included a focus on the limitation of traditional sources of legitimacy in representative democracy with a critical examination of the promises of collaborative governance arrangements to bring about more legitimate and effective decision-making. Further, she has applied gender perspectives in her work and seeks to develop this further in studies of public participation. Her latest publications are: "Gender Equality in Conservation Management: Reproducing or Transforming Gender Differences Through Local Participation?" (forthcoming) in Society and Natural Resources and "The consequences of avoiding conflict: lessons from conservation planning for Europe's last wild reindeer" (co-authored with Tim Richardson and Eirin Hongslo) (2018) in the Journal of Environmental Planning and Management.

MAGNUSSEN, TONE

Tone Magnussen is a Senior Researcher at Nordland Research Institute. The institute is a joint-stock company, co-owned by Nordland University and the Nordlandsforskning Foundation. Magnussen has special interests in interdisciplinary studies, constructions of place, and integration processes. From 2017-2021, she takes part in the research project: Cit-egration-Sustainable diverse cities: Innovation in Integration is funded by the Norwegian Research Council BYFORSK-initiative and the SAMKUL-programme.

MEHRA, RAKHI

Rakhi Mehra, is co-founder of mHS CITY LAB, an interdisciplinary social enterprise addressing safety and affordability of housing for urban poor in India. She also holds university affiliations with Bocconi University in Milan, IE Business School in Madrid and Franklin University Switzerland as Visiting Faculty on Social Innovation. A Rhodes scholar and an MBA from Harvard ('09) Rakhi has worked with World Bank, CARE India, Ashoka Fellows, Grameen Bank, RABO Bank, Jeffery Sachs' office at Columbia University. She studied Economics at St. Stephens College, Delhi (2001), and read Politics, Philosophy & Economics at Oxford University (2001-03). In 2011 she was awarded the Social Enterprise Fellowship by Harvard Business School.

MELCHIORRI, MICHELE

Michele Melchiorri is a M.S. graduate in Urban Planning and Policy Design at Politecnico di Milano, Italy. He holds a MA in International Public Affairs awarded by the LUISS School of Government in 2018. Since 2012 he has been collaborating with International Organisations including the United Nations Economic Commission for Europe, the World Bank, and other NGOs for research and projects in the field of sustainable urban development, housing, real estate and urban planning. His research is in the field of urbanization, disaster risk reduction and on the linkages between international institutions and sustainable urban development in the framework the 2030 Development Agenda. He is a member of ISOCARP since 2015.

MELCHIORS, LUCIA CAMARGOS

Lucia Camargos Melchiors is an architect and urban designer from Brazil, with experience as a practitioner and a lecturer. In Brazil, she worked as a registered architect for 15 years, being involved in several urbanization projects, apartments buildings and large-scale commercial projects. She also worked as a member of the board of directors of the Institute of Architects of Brazil-RS. During the last six years Lucia has been working as a lecturer in architecture and urban design courses in Brazil, China and New Zealand. With a post-graduation degree in Cultural Heritage at Urban Centres and a Master degree in Urban Planning, at the moment she is a PhD Candidate at the Urban and Regional Planning Programme at the Federal University of Rio Grande do Sul, Brazil, and is collaborating with Unitec Institute of Technology, New Zealand, as a lecturer in the Architecture Pathway.

NEEDOBA, AMELIA

Amelia Needoba is an urban forester with Diamond Head, a boutique environmental consulting firm in Vancouver. Prior to joining Diamond Head, she held the role of Urban Forester with the City of Melbourne. Amelia specializes in developing and implementing urban forest strategies for cities. Her work involves diving deep into the data, policy, history and governance to find the narrative unique to that city's urban forest. Amelia works with a multidisciplinary team at Diamond Head to engage cities staff, professionals and the community in solving urban forest problems and writing comprehensive strategies.

NEUBERT NIKOLAS

Nikolas Neubert is an internationally experienced urban planner and heads AIT's unit for Sustainable Buildings and Cities. He holds degrees in urban planning, architecture and urban design. He served as a consultant and project director to ministries, municipal governments and private institutions, working on the strategic development of cities, regions and metropolitan areas. Starting his career in the capital city department of the Senate Administration for Urban Development in Berlin he made sustainable and resilient urban development a key driver of his path. This brought him to Brazil's capital where he participated in the realization of Latin America's first certified sustainable district. Later on he was involved in innovative urban development and research projects for ARUP (Shanghai), AS+P Architects, Planners (Shanghai) in the Middle-East, Asia-Pacific before he came back to Europe to lead the branch office of AS+P in Ingolstadt.

PAI, MADHAV

Madhav Pai is the Director for the WRI India | Ross Centre. The centre founded in 2014 combines the strength of WRI's EMBARQ network for sustainable transport with the Institute's expertise in energy & climate, adaptation, water, and governance and aspires to deliver the goal of sustainable cities. He continues to be director for EMBARQ India a program he co-started 10 years ago. WRI India | Ross Centre currently engages over 50+ professionals in 4 offices across India and has supported 15+ cities on sustainable transport, urban planning and development projects. Madhav has close to 20 years' experience leading, designing and managing urban programs and projects in India, Asia and United states. He is a Civil Engineer from Mumbai and holds a Master's Degree in Transport Planning from University of California Berkeley.

PREISS, JÜRGEN

Dipl. Ing. Jürgen Preiss has been working at the Vienna Environmental Protection Department since 2007 and is the Deputy Head in the field of spatial development. He has been project manager of the Urban Heat Island (UHI) - Strategic Plan Vienna, chiefly responsible for the Building Greening Program. He also heads the "Green and Open Spaces" working group of the project "ÖkoKauf Wien" and is responsible for implementation of strategic environmental goals within the framework of various planning instruments (Urban Development Plan, Detailed Concepts for the Urban Development Plan, Mission Statement for urban development, Climate Protection Program, Smart City Framework Strategy, general project plans). Besides his tasks in the city administration, he organizes and participates in teaching and information events at universities, schools, and other public events.

RANGWALA, LUBAINA

Lubaina is Manager – Urban Climate Resilience at the WRI India Ross Centre for Sustainable Cities. Her research cuts across various aspects of urban poverty, climate vulnerability, livelihood protection and resilience planning. Currently, her work focuses on enhancing resilience in urban poor communities, adopting participatory planning methods to influence city resilience plans. Prior to this role, Lubaina managed urban planning projects at WRI India and provided key recommendations on off-street parking reforms to the Mumbai Development Plan in 2014. She also co-authored EMBAQ India's Safe Access Manual that is a compilation of emerging work around safe and secure access to mass transit nodes, in India. Prior to WRI, she has worked as a researcher and a teacher at institutions in India and the United States. Lubaina, is an urban researcher, with close to 10 years of experience on urban poverty, mobility, housing, and community & economic development in Indian and American cities. She holds a Bachelor's degree in Architecture from KRVIA, Mumbai, India and a Dual Master's degree in Architecture and City and Regional Planning from the University of California, Berkeley.

REINAR, MATHIAS B.

Mathias Brynildsen Reinar has a Master in political science from The Norwegian University of Science and Technology, with a specialization on Norwegian foreign policy and Russian politics. From 2012–2018 he worked in the Office of the city Auditor in Oslo municipality, doing evaluations of public policy measures within fields such as urban planning, environmental management, transportation infrastructure, culture and public procurement. As a researcher at the environment and society research group at Nordland Research Institute, his main interest lies in in urban research, closely following the different development projects in the city of Bodø.

ROGERS, MEGAN

Megan Rogers is a dedicated and resourceful environmental consultant and biologist with 3 years of experience in research, environmental science, and consulting. Since starting at Zoetica, Ms. Rogers has worked on a variety of environmental assessment and mapping projects. She has conducted research for, and provided technical reviews of, environmental impact statements for large mining projects, wildlife mitigation and management plans, water licence applications, and road development proposals. She has also reviewed federal Acts on behalf of First Nations including the Fisheries Act. Ms. Rogers has been instrumental in the development of wildlife monitoring programs, worked to enhance the capacity of the Lower Fraser Fisheries Alliance fish habitat restoration program, and completed engagement activities, such as liaising and collaborating with First Nations, and stewardship groups on environmental mapping projects.

SKORSTAD, BERIT

Dr. Berit Skorstad is a professor of sociology at Nord University in Bodø, Norway. Her research has focused on environmental politics, attitudes and ethics and she has published several articles and books in these topics. Skorstad leads the Research group for environment, arctic and international studies at the faculty of social science, at Nord University. Here, she also teaches in environmental sociology and sociological theory. Skorstad has participated in a number of international research projects the last two decades both in environmental and ethical aspects of fisheries in Europe and coastal zone management in Europe, as well as environmental and social aspect of mining projects. The last years her research topics also regards urban development and its environmental impacts.

SCHEERBARTH, BENJAMIN

Benjamin was educated in Harvard University. Professional experiences range across grassroots urban development, commercial masterplanning, municipal capacity building and research.
Benjamin's work has been published by, among others, Hatje Cantz, LAF and Black Square Press and exhibited at the 2016 Venice Biennale. He is Chair of the Scientific Committee of the International Society of City and Regional Planners and serves on the board of Berlin's Harvard Club.

SONG, JIE

Jie Song is the deputy director of Wuhan Land Use and Urban Spatial Planning Research Center (WLSP), senior planner, registered planner, and registered architect. From 1995 to 2016, she was engaged in planning and architectural design in Wuhan Planning and Design Institute, served as assistant dean, department manager, chief engineer etc. In 2006, she studied in the University of Illinois in Chicago, America for one year and enjoyed the special allowance of Wuhan municipal government from 2010. She was in charge of more than 100 urban planning and architectural design projects, such as East Lake Green Heart, East Lack Greenway, Sino-French (Wuhan) Eco-city Overall Planning, Sino-French (Wuhan) Eco-city Overall Urban Design, the 10th Chinese International Garden Art Expo Overall Planning, Tourism Function Promotion Planning of Wuhan Two Rivers and Four Banks etc.

STEPHENS, RIC

Ric is an educator, consultant and civic advisor helping to create meaningful and memorable places in over 30 countries. Mr. Stephens is currently an adjunct instructor for Marylhurst University, Portland Community College, Portland State University and the University of Oregon where he teaches courses in urban planning, international development, global business and unmanned aircraft systems. Mr. Stephens' consultancy, Stephens Planning & Design LLC , is engaged in projects and programs in community, tourism and international advisory planning; urban, regenerative and experiential design; and, information and communications technology, including geospatial analysis and cartography, multimedia and unmanned aircraft systems.

Ric and his wife, June, live in the City of Beaverton, Oregon where they serve on the local Community Emergency Response Team.

TEMESGEN, AMSALE K.

Amsale K. Temesgen is currently undertaking her PhD studies with specialization in Ecological Economics at Nord University, Bodø, Norway. Her PhD project focuses on Human wellbeing in sustainable communities where she studies the intersection between wellbeing/quality of life and sustainability. She uses both quantitative and qualitative approaches in her research and draws on perspectives from Economics, Sociology and psychology. She is currently focusing on methods that involve civic engagement to inform policymaking. Amsale's background is in Development and Resource Economics. She has over ten years of research experience at Fafo, Institute for Applied International Studies, with a focus on living condition studies in Africa, the Middle East and Asia. Her research involved understanding the factors and determinants of living conditions among populations of fragile states and in poor and middle-income countries. The results of these research activities contributed to international reports including State of the World's Cities Report of UN-Habitat, World Development Report of the World Bank, and reports by the Ministry of Foreign Affairs of Norway.

TONG, DANDAN

Dandan Tong graduated as a Master in Urban Planning and Development at the University of Melbourne in Australia. She is urban planner in Wuhan Land Use and Urban Spatial Planning Research Center, major in charge of international project cooperation and worked on several strategic urban research projects, such as Transit Metropolis Development in Wuhan, East Lack Skyline Control Planning etc.

TÖTZER, TANJA

Tanja Tötzer has a Doctoral Degree in Landscape Architecture and Landscape Planning from the University of Natural Resources and Applied Life Sciences, Vienna and is researcher at the Austrian Institute of Technology, AIT since 2001. Her scientific interest lies in the field of sustainable development of urban regions, participatory planning processes, impacts of climate change and GIS-based spatial analysis of interrelations in spatial systems. She has been project and task manager in various national and European research projects (e.g. PLUREL, Geoland) and has been working over the past years in several inter- and transdisciplinary projects where she was in charge of collaborating with researchers from different disciplines; and of communicating and developing visions and scenarios together with local practitioners (smart city projects, future scapes, mediation process for the Vienna Airport). Recently she has been engaged in projects dealing with impacts of and adaption to climate change such as Aspern Microclimate, UFT-Adi (Urban fabric types and microclimate response), Private Adaptation to Climate Change with focus on winter tourism, clarity-h2020.eu, green resilient city and LiLa4Green.

WANG, XINXIN

Xinxin Wang is a Lecturer in the Landscape Architecture programme at Unitec Institute of Technology. Before her career as a lecturer, Xinxin worked 17 years as an urban planner and designed large-scale projects for a number of cities in China. One of her projects was recognised for awards from Urban Planning Society of China, eight of them were recognised for awards from Shandong Planning Association. Xinxin is a member of International Society of City and Regional Planners (ISOCARP) and Registered Planner of China. Xinxin has expertise in Comprehensive City Planning, High-density Development and Transit-Oriented Planning. Her current research focuses on applying New Zealand environmental planning methods to China's planning framework, as well as applying China's urban growth models to Auckland regional development.

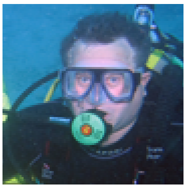
ABOUT THE EDITORS

↑↑ TOC

MAŁGORZATA HANZL

Małgorzata Hanzl holds her MArch and PhD in Architecture and Urban planning from Lodz University of Technology, Poland. She completed her MArch diploma at Lyon Ecole d'Architecture. Before entering academia, she practiced urban planning and urban design, as well as architecture, for several years. She continues to consult as an urban planner.
She has extensive experience in teaching and lecturing. Currently an Assistant Professor of Urban Planning in Lodz University of Technology, she also teaches Architecture for Society of Knowledge in the graduate school of the Warsaw University of Technology. She maintained her Fulbright Scholarship as a Visiting Researcher in the SENSEable City Laboratory MIT, Cambridge MA.
Following her research interests, she has been actively involved in publishing and writing for several urban planning, citizen journals, as well as blogging. Małgorzata's main area of interest and experience is public participation in urban planning, internet communication, GIS, rehabilitation especially in the context of post-industrial cities, urban morphology, anthropology, and culture related studies. She is the author of several journal publications and serves as a reviewer and an advisor on scientific boards and committees. She also serves as the ISOCARP Vice President for Publications.

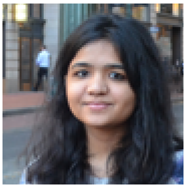
JIM REILLY



Jim Reilly began his planning career with the award-winning firm of Wallace, McHarg, Roberts and Todd, where he worked for nine years. His major assignments included portions of the Plan for the Inner Harbor, in Baltimore, MD; and elements of the Metro Systems in Washington, DC and Baltimore, MD. Eventually Jim was a Senior Project manager for the Plans for Abuja, the New Federal Capital of Nigeria. He then started his own (but not financially successful) company developing computer programs to assess economic impacts from planned improvements. Later, he worked for over 20 years as a senior planner and regional scientist for the State of New Jersey (USA) Office of State Planning and for the State of Maryland (USA) Department of Planning. While at these state agencies, Jim conducted statistical research

about land use change and various impacts associated with change.
He is the author of numerous articles in various refereed journals as well as the author of GAMe, a computer model to predict future small area forecasts of land consumption, population, and jobs.
Jim is a disabled veteran, having served in the US Army (Reserves) Medical Corp for 25 years as well as two wars. He is the recipient of 35 medals for his service.
Jim is enjoying retirement with his wife, scuba dives, fly fishes, and travels.

MAHAK AGRAWAL



Mahak Agrawal holds a Masters and Bachelor's degree in Urban Planning and Physical Planning, respectively from the School of Planning and Architecture, New Delhi, India. She has been working on the issue of open defecation and sanitation deprivation with research institutions and local government since late 2013. She has also worked, in different capacities, with the following institutions: Town and Country Planning Organization, New Delhi; Irrigation and Flood Control Department, New Delhi; Directorate of Environment, New Delhi; Indian Institute of Human Settlements, New Delhi; Norway Institute of Transport Economics, Oslo; Dubai MUF-ISOCARP, University of Chicago, Illinois and the World Bank Organization, India.
Mahak's main area of interest and experience includes environment sensitive urban planning, land economy, WASH and climate action. Following her research interests, she often writes for the London School of Economics and Political Science, South Asia Centre and has published research papers with Springer Bulletin, International Society of City and Regional Planners or ISOCARP, Association of European Schools of Planning or AESOP, Institute of Town Planners, India to name a few.
She is the recipient of Prof. V.N. Prasad Best Thesis Award, for the best thesis in Master of Planning in India and T.J. Manickam award for overall excellence in Master of Planning and Architecture, India. Lately, she has been working on climate change and the resilience of mega cities of India, with key findings published in local news media.

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Knowledge for Better Cities

ISOCARP	International Society of City and Regional Planners
AIU	Association Internationale des Urbanistes
IGSRP	Internationale Gesellschaft der Stadt- und Regionalplaner
AIU	Asociación Internacional de Urbanistas

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