Urban Task Force Cancun 2006

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About the Urban Task Force

The Urban Task Force (UTF) is an initiative form the International Society of City and Regional Planners (ISoCaRP) directed at reinforcing its position as a recognised international association of independent professionals concerned with urbanism whilst reaching out to local authorities, and communities at large, to provide expert and unbiased advice on pressing planning issues.

The UTF is organised as a one week workshop sponsored by Cancun's local authorities and undertaken by specially designated ISoCaRP Senior Planners.

The UTF taking place in Cancun in February 2006 intends to provide local authorities with a fresh, rational, sustainable and implementable set of ideas towards urban improvement after the incidence of hurricane Wilma in October 2005. The diagnosis and ensuing planning recommendations aim for Cancun to be better prepared for potential natural disasters whilst inspiring an urban model that balances growth and a sustainable horizon, aiming for a dynamic economy, an integrated society, and an improved quality of life for all citizens in the region

Team

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Background

Cancun's population is approximately 500,000 inhabitants on the tip of the Yucatan peninsula, in the state of Quintana Roo, Mexico.

Brief history In the early 1950s Cancun was an almost unpopulated and undeveloped island just off the Caribbean Sea coast of the Yucatan peninsula. It was the home to three caretakers of a coconut plantation and small Maya ruins. The government of Mexico decided to develop a tourist resort on Cancun, which was originally financed by a USD $27 million loan from the Inter-American Development Bank. A causeway was built to link Cancun to the mainland, together with an international airport and an entire city for workers, with housing, schools and medical facilities.

Development of Cancun started in 1970 and grew rapidly in the 1980s. Despite initial scepticism that forced the Mexican government to finance the first eight hotels, Cancun soon attracted investors from all over the world. The city has grown rapidly, covering the former island and the nearby mainland. Most 'cancunenses' here are from Yucatan and other Mexican states. A growing number of residents are from the rest of America and Europe.

Urban form Three main areas can be identified in Cancun's urban form. The first area consists of a narrow strip of 22 km extending North-South along the axis of Boulevard Kukulkan, between the Nichupté Lagoon and the Caribbean Sea. This linear development, aptly called the Hotel Zone, concentrates tourism-related development with multitude of resorts, hotels and support businesses, as well as historical ruins.

The second area is known as Pueblo de Apoyo (literally, Support Town), and is located North of the Kukulcan strip. Its distinctive pentagonal shape was planned by Enrique Landa. This area is

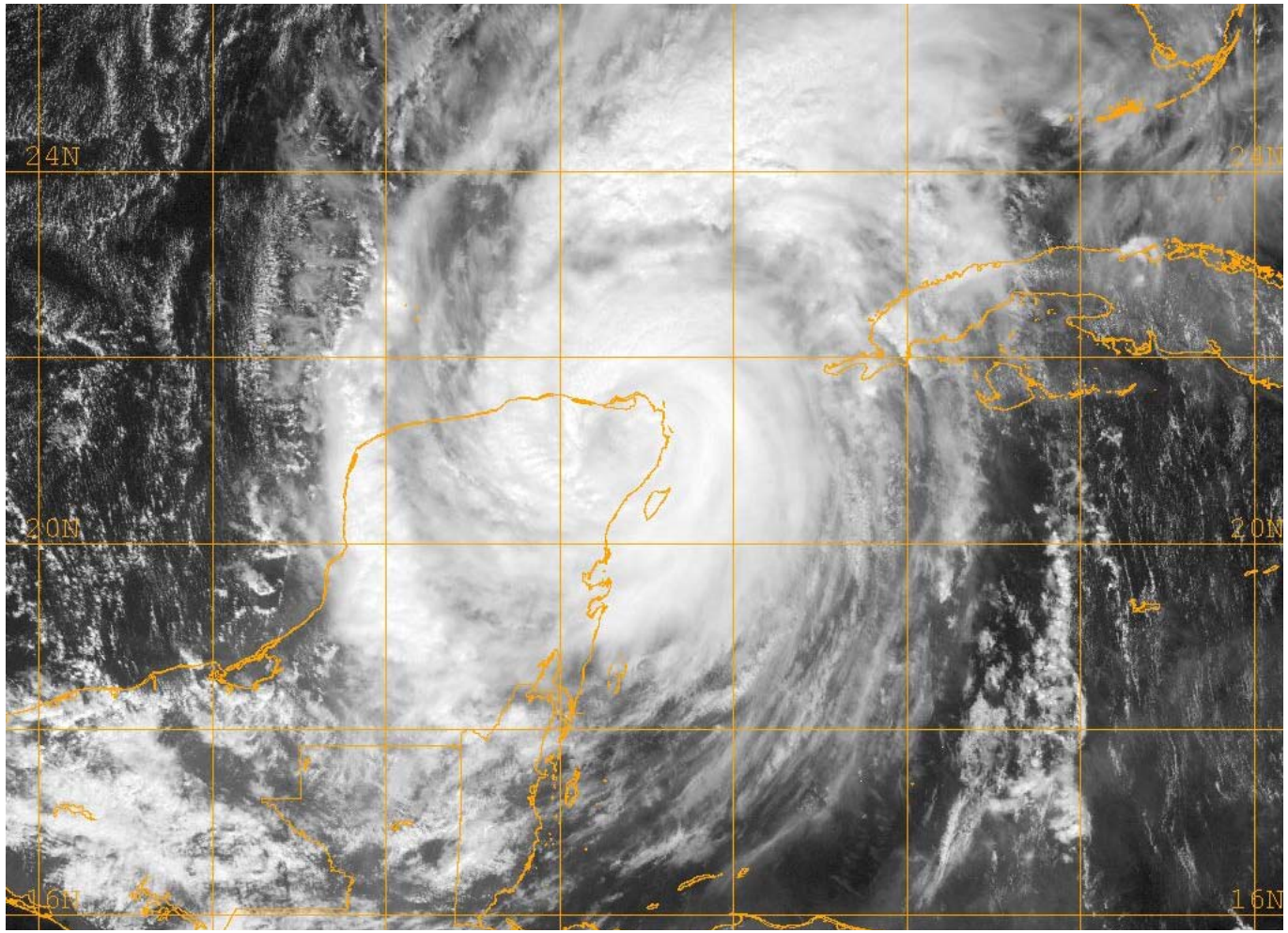
otherwise known as centro (downtown) and concentrates a number of civil amenities such as the city hall. Its character is mainly residential.

The third area, Zona de las Regiones, located to the North of the centro, is an attempt to cope with Cancun's considerable growth. The urban fabric in this area consists of a large orthogonal carpet, dedicated to residential use, with single family housing the dominant typology. Its capacity is for a remarkable half a million of people. However, its roads are narrow and open areas and civic amenities scarce.

Hurricane Wilma Wilma was the third Category 5 hurricane of the 2005 season. At its peak, it was the most intense tropical cyclone ever recorded in the Atlantic basin and the tenth most intense globally, with the lowest atmospheric pressure ever recorded in the Western Hemisphere of 882 millibars at sea level, exceeding the record previously held by Hurricane Gilbert, which also had impacted the Yucatan Peninsula.

On 21 October, Hurricane Wilma made its landfall on Mexico's Yucatan Peninsula as a powerful Category 4 hurricane, with winds in excess of 150 mph. The hurricane's eye first passed over the island of Cozumel, to reach Playa del Carmen at around midnight on 22 October EDT, with winds near 140 mph. Portions of the island of Cozumel experienced the calm eye of Wilma for several hours with some blue skies and sunshine visible at times. The eye slowly drifted northward, with the centre passing just to the west of Cancun. Some portions of the Yucatan Peninsula experienced hurricane force winds for well over 24 hours. The hurricane began accelerating in the early morning hours of 23 October, exiting the north-eastern tip of the Yucatan Peninsula and entering the Gulf of Mexico as a Category 2 storm.

Wilma made several landfalls, with the most destructive effects felt in the Yucatan Peninsula, particularly in Cancun. At least three deaths have been reported, numerous persons reported missing, and the insured damage is estimated at between US$5 and US$8 billion. The devastation was almost total with many of the principal roadways from the Hotel Zone, which was completely flooded. It has been estimated that 95% of the tourism infrastructure was seriously damaged. Once the storm left the peninsula, a number of the beautiful beaches of Cancun had been washed away. Thousands of local and foreign tourists were hosted in improvised refuges. All airport and harbour operations were cancelled between 21 and 25 October due to weather conditions. It is estimated that the local tourist industry lost over US $15 Million daily. Many houses were devastated, and many jobs were lost.



Scenario Planning

Scenario planning is a method for learning about the future by understanding the nature and impact of the most uncertain and important driving forces affecting our future. It is a group process which encourages knowledge exchange and development of mutual deeper understanding of central issues important to the future. The goal is to craft a number of diverging stories by extrapolating uncertain and heavily influencing driving forces. The method is widely used as a strategic management tool, but has also been used for enabling other types of group discussion about a common future such as territorial planning.

The team adopted the scenario planning methodology with the aim of provoking a thorough reflection on the challenges and opportunities facing Cancun. Therefore, the outcome should be viewed as a tool to support the Municipality and its stakeholders in preparing the Strategic Plan 2030.

Informed by a series of presentations with local experts in regional and municipal planning, GIS and meteorology, and a number of dialogues with representatives of the private sector, the team was in position to propose alternatives that illustrate hypothetical yet possible futures for the region, each associated with a unique set of public benefits and costs.

The team elaborated the following scenarios for consideration:

Scenario A The economic base of this scenario focuses on mass tourism. In this setting, the competitive factor for Cancun can be described as "sun and sand at an attractive price". Cancun's competitors are those destinations which can offer comparable climate conditions at comparable prices.

The target consumer of this scenario are those tourist concerned with price, a group that generally chooses all-inclusive packages for their holidays. Hence, the main actors in this model are the tourism industry integrators, international tour operators and hotel chains, such as Barceló, Melia and Starwood.

In tourism industry models based in the quantity of visitors, the role of the host territory can be described as a provider of natural resources and workforce for a fee. In most such cases, resource consumption (i.e. land, water, energy, waste) is very high and the economic margin for locals rather low. The workforce's required skills can be considered as low. The model's labour force comprises mainly low wage service industry workers, who have reduced opportunities for cultural development and little access to broader skills such as Information Technology as this is not usually required in most jobs created.

In this scenario the role of institutional policy making can be considered as marginal. The main actor in the scenario is the private sector, specifically travel industry integrators who control key elements in the value chain (visitor's transport from and to their origin, accommodation, leisure and food and drink consumption) and commoditise local resources and labour. This is the no-action scenario as it is the most likely to happen should no policy initiative be undertaken to redirect current development trends.

Scenario B This hypothetical future contemplates a change in Cancun's economic base towards a mixed model by which Cancun would act as a services hub of regional stature.

The economic base consists of a combination of the currently existing tourism industry, which would be retained to some extent, with the addition of a cluster of services focusing on the tourism industry reaching the Yucatan peninsula and the near Caribbean region. Services provided to the region can include financial services, telecommunications, education, health, transportation, logistics and distribution, and light manufacturing.

The scenario's competitive factor can be described as "employment in paradise" as the capacity to attract skilled human resources to operate the model is vital. As said, the target consumers are the professionals in addition to a less relevant visitor figure. The model's main actors are the public sector, which is responsible for providing the enabling policy and the required infrastructure, and the corporations, which are required to address a location commitment to create a services critical mass.

Cancun's resource consumption, as a regional centre providing services to support the regional tourism industry, can be described as medium as the model calls for a compact, higher density urban development. Margins for service-focused cities tend to be high if they are capable of aggregating significant value for their surrounding region. Education and cultural development are crucial in this scenario, as the economic model requires high workforce skills, with special mention to information and communications technology.

The role of institutional policy making is critical. Without the vision and initial impulse from the public sector it is unlikely that the private sector can independently undertake such transformation as it does neither have enough human resources to implement such complex, comprehensive vision nor the financial mechanisms to avoid short term obligations.

Scenario C Keeping its focus on the tourism industry, this Scenario contemplates a switch in target market from mass tourism to a qualitative-based profile with less number of visits. In this setting, Cancun's competitive factor is its capacity to offer a distinctive tourist experience adding cultural, educational and health related activities to those pull factors expected to be found in a sun and sea destination. The target segment consists of tourists looking for environmental quality, historic and cultural heritage, unique design and construction, and unparalleled service.

To make this model possible, a close cooperation between sectors is required. Institutional instruments must be put in place in order to ensure quality in new development and standards of service, and to financially support the transformation of the built stock from mass-oriented to increase its competitiveness in terms of quality. The dynamism of the local entrepreneur is vital as the model is based on a number of local private sector ventures rather than relying in large tourism industry multinationals. The concordance with environmental lobbies in development policy is also indispensable as the model needs the highest environmental standards to be competitive.

The Cancun role can be therefore describes as a quality provider of visitor experiences capitalising on natural and built resources and innovative business initiatives. As concentration of visitors is lower compared to mass-driven models, it is viable to think that the burden on the environment would decrease. A model based on quality requires achieving

significant margins. For that, an unparalleled service level is needed; hence, workforce skills are important as well as an efficient ICT system.

The role of institutional policy making is very important. Besides guaranteeing that the development model preserves both environment and built heritage, the public sector has to provide the initial impulse in the transformation of the economic model, including educational campaigns, financial support for renovation of the hotel infrastructure, micro credits for local entrepreneurs, workforce capacity building, and providing mechanisms to ensure service quality.

	Scenario A	**Scenario B**	**Scenario C**
Economic base	Focused on mass tourism	Mixed, cluster tourism services, convention destination, tourism	Focused on quality tourism
Cancun role	Provider of natural resources and workforce for a fee	Regional centre providing logistics and services support in tourism industry to a broad region; transportation hub	Quality provider of visitor experiences capitalising on natural and built resources and innovative business initiatives
Urban policy role	Marginal	Crucial	Important
Competitive factor	Sun and sand at an attractive price	Employment in paradise	Preserved environment and unique cultural heritage
Consumer	Tourist concerned with price, generally opting for all inclusive packages	Professionals; tourists to a lesser extent	Tourists looking for environmental quality, historic and cultural heritage, unique design and construction, and unparalleled service
Main actors	Tourism industry aggregators, international tour operators and hotel chains	Public sector infrastructure and corporations	“Quality police”, hotel entrepreneurs (perhaps local), environmental lobbies
Required amount of consumers in economic model	High	Medium	Low
Margin	Low	High	High
Required workforce skills	Low	High	Medium
Culture and human development	Low	High	Moderate
Information Technology development / use	Low	Crucial	Low

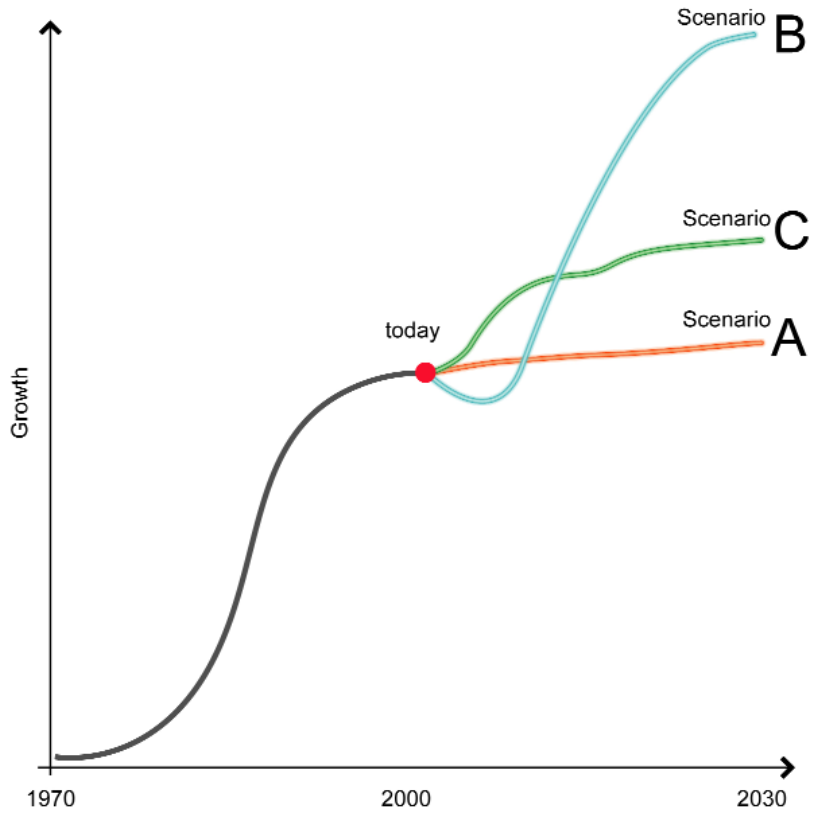
Implications In Scenarios A and C, Cancun continues to be a major tourism destination and consequently the tourist industry remains the predominant economic sector. The difference between them is that scenario A continues to focus on the tourism market presently drawn to Cancun, while scenario C envisions a market shift towards the luxury or exclusive niche market.

Whilst "A" shows immediate stable conditions, in the long term we foresee only a modest growth perspective, if not a decline. Scenario C, which accommodates tourism programme in a more distributed development pattern, would offer stability in the long term by preserving the natural beauty of the region.

Scenario B hypothesises a rather radical diversification of the economy and a consolidation of the metropolitan area. This means a need for higher investments in infrastructure on the short term, but with strong benefits on a long term. The following table illustrates the programmatic assumption for each scenario.

The tourist scenarios A and C will always show urban growth mainly driven by tourist accommodation as well as housing for tourism industry employees. Scenario B however depends highly on metropolitan density for reasons of interdependence of diversified urban functions.

Thus it can be concluded that growth in scenarios on A and C, strongly related to the tourism industry, will always lead towards extending territorial boundaries, while scenario B will have to accommodate growth by the consolidation of the metropolitan area by increasing the existing density within the city boundary.



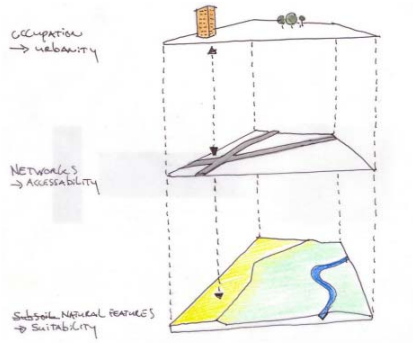
Scenarios

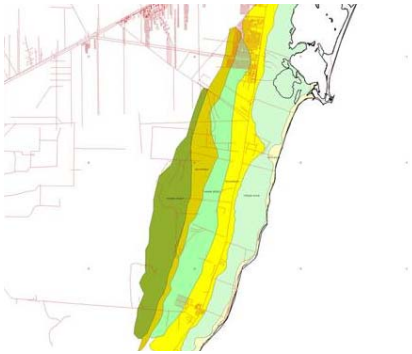
		Base		Base +30	Escenario A +30	Escenario B +30	Escenario C+30
Cancun - población		800,000		1,000,000	1,000,000	1,500,000	900,000
Riviera Maya - población		100,000		500,000	500,000	500,000	600,000
Población total		900,000		1,500,000	1,500,000	2,000,000	1,500,000
Cancun - personas por vivienda	5	160,000	3	333,333	333,333	500,000	300,000
Riviera Maya - personas por vivienda	5	20,000	3	166,667	166,667	166,667	200,000
Total personas por vivienda	5	180,000	3	500,000	500,000	666,667	500,000
Cancun - habitaciones		30,000		60,000	60,000	30,000	45,000
Riviera Maya - habitaciones				45,000			
Total - habitaciones				105,000			
Densidad constante, incremento de área							
Area actual urbana de Cancun	ha	14,000		17,544	17,544	26,316	15,789
Densidad	hab/ha	57		57	57	57	57
Viviendas por ha		11					
Incremento de área	ha			3,544	3,544	12,316	1,789
Area constante, incremento de densidad							
Area actual urbana de Cancun	ha	14,000		14,000	14,000	14,000	14,000
Densidad	hab/ha	57		71	71	107	64
Vivioendas por ha							
Incremento de densidad	hab/ha			14	14	50	7

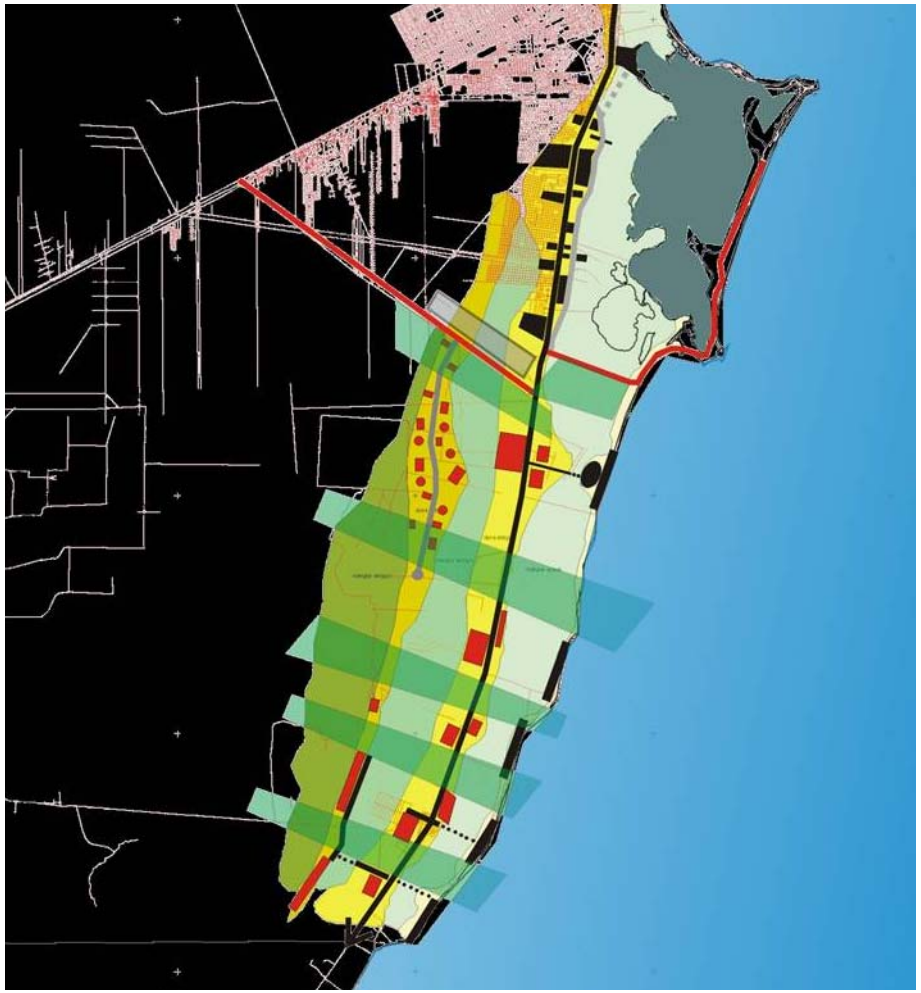
Context

Topography Ancient systems of sand mounds exist along the coast. Lowlands between these high features trap water during hurricanes and can cause extensive flooding and water damage. While the development of a number of drainage channels will contribute to solve local flooding during normal rain events, it would not be cost effective to design a drainage system to cope with hurricane-induced flooding.

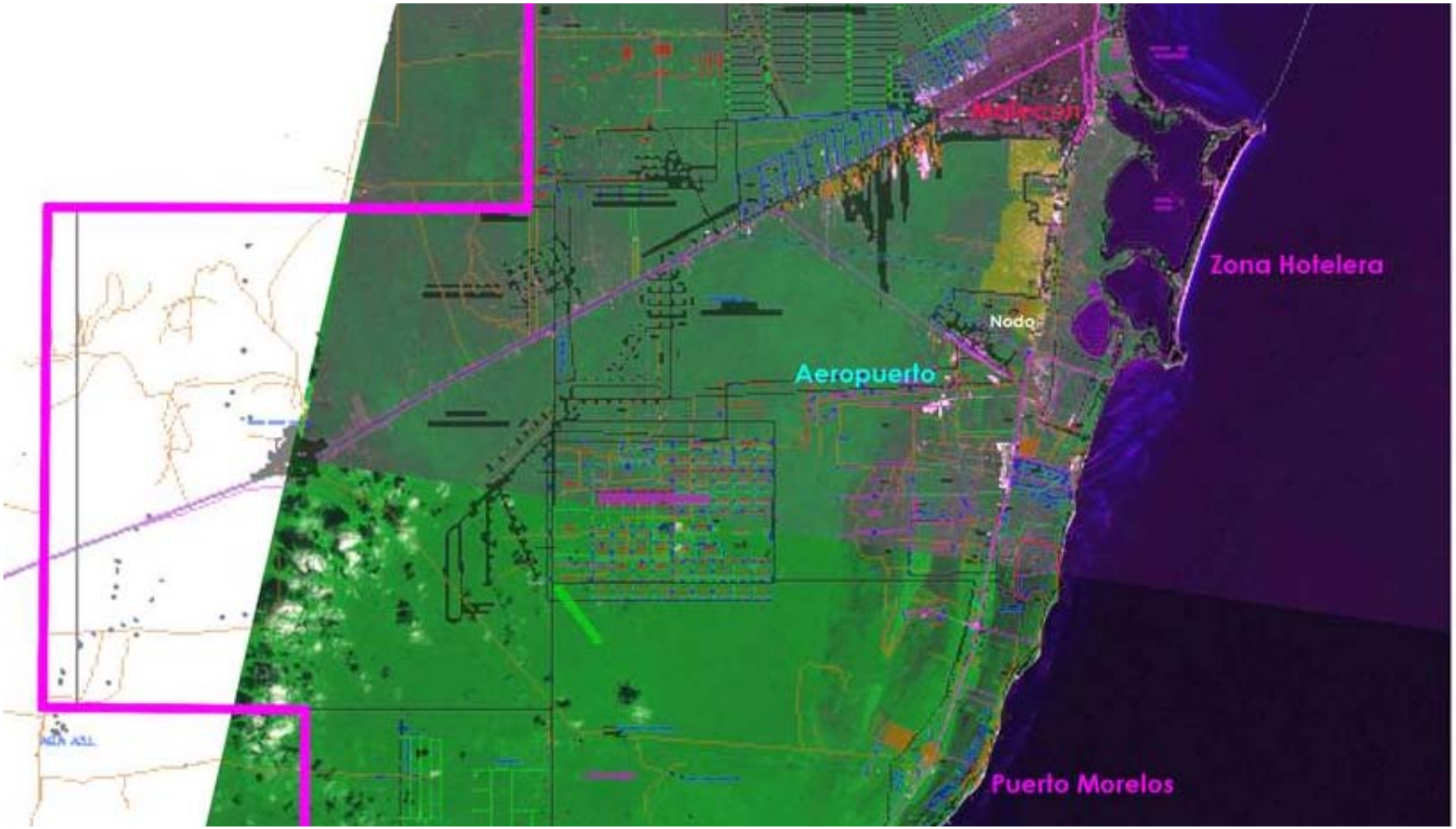
Additionally, improved drainage into the existing mangrove lagoons and wetlands could incur negative ecological impacts. Therefore, a design principle that focuses growth along the tops of these mounds and avoids development in low-lying locations has been considered. The team has also proposed a second design principle that creates a limited number of horizontal integrations, crosswise through the mounds, which might be developed as interconnecting roadways and visual corridors.







Context: Cancun today



Scenario A: "Ciudad Turismo"

This scenario assumes that the region's tourism infrastructure, residential neighbourhoods and commercial districts will continue to develop much as they have done in the past 35 years.

Future development is assumed to preserve the current lineal growth pattern and other tendencies previously established. The actual Zona Hotelera will increase its density. The Pueblo de Apoyo where support workforce resides is expected to grow, although to a lesser degree, based on the existing grid pattern extending in a North West direction. This scenario has a strong parallel with the coast development of Waikiki, Hawaii, dominated by large-scale tourism developers.

Further expansion of the Hotel Zone along the coastline would increase the pressure on infrastructure and urban services such as the provision of energy and waste management. Emission will also increase, as well as land and water consumption. A larger service sector will result in increased stress to the work-force residential areas outside the city.

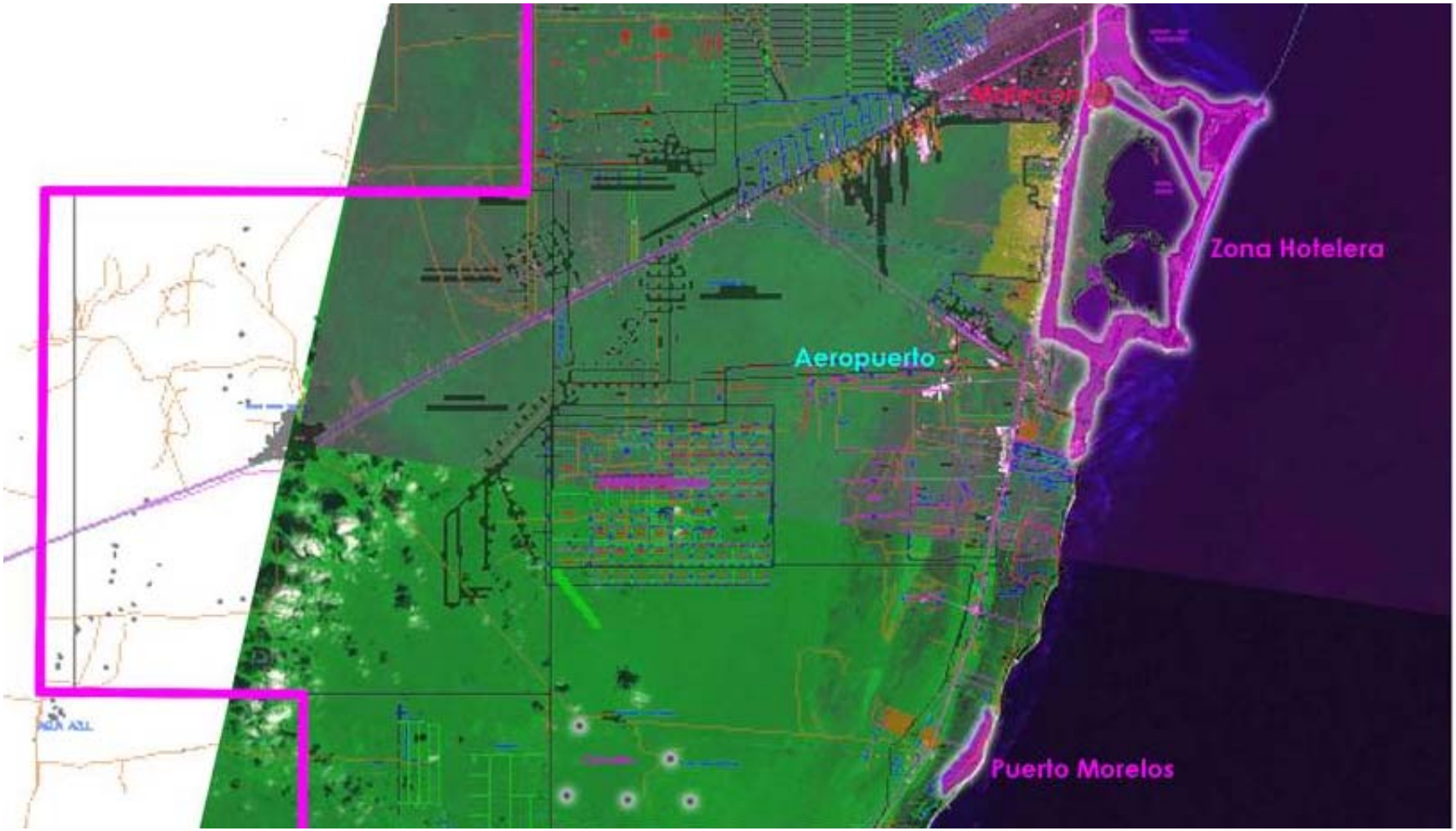
It is expected that the density increase of the Zona Hotelera will lead to higher pressures on traffic and very likely a congested situation at the connecting intersection nearby the city centre.

This suggests that abroad and comprehensive traffic strategy needs to be prepared, considering public transport as a vital element.

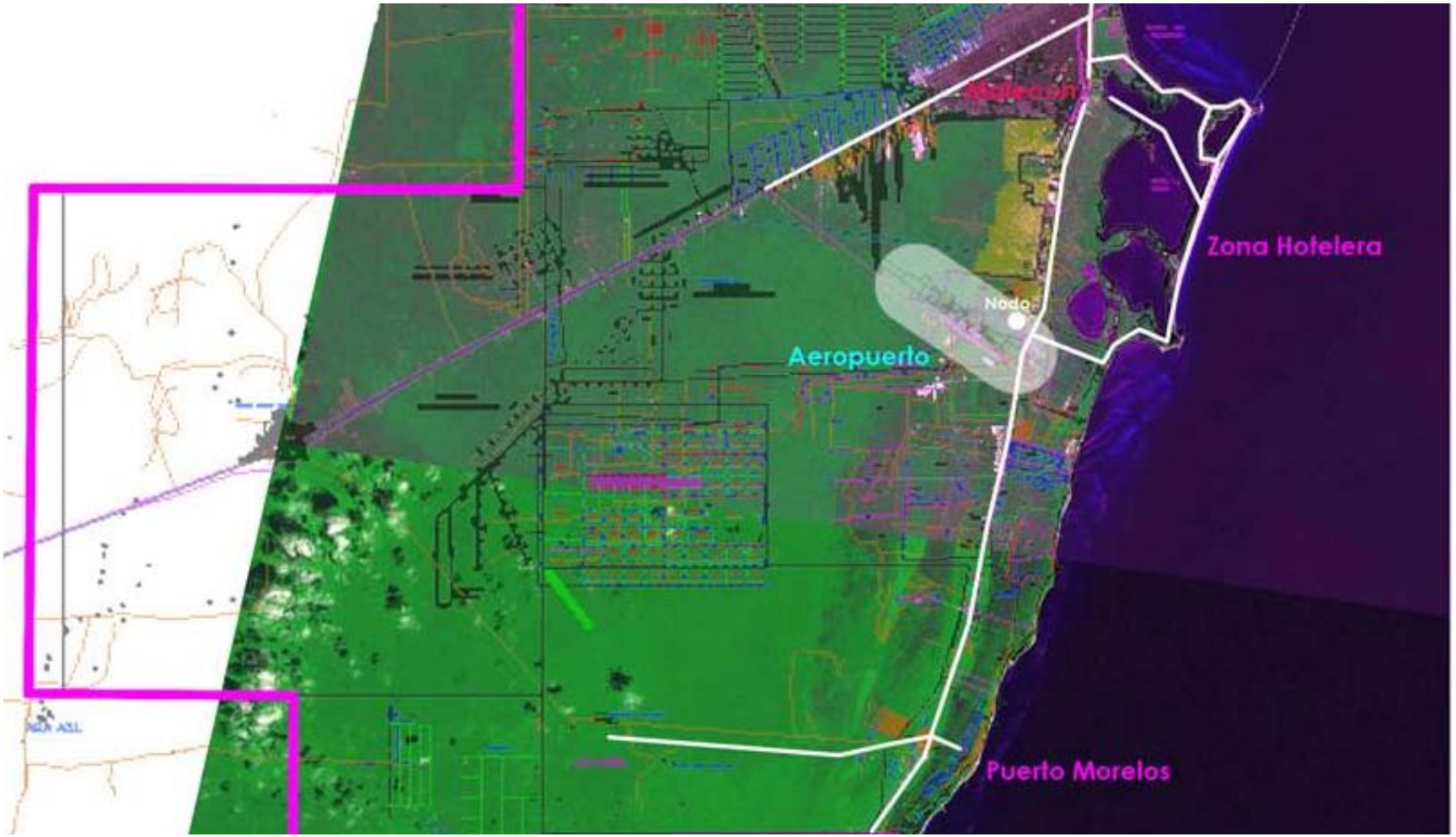
In this regard, it was made known to the team that the local government is already considering a multi-million dollar bridge across the Nichupte lagoon. Whist Scenario A is the only of that would create conditions which might support this investment, the UTF team recommends reconsidering the bridge project as perhaps increasing intersection options and improving the circulation pattern at both ends of the Hotel Zone could render the bridge unnecessary.

In contrast, the area existing between the airport and the city centre is to be considered as an independent project that can be implemented in parallel or at a later stage. It is believed that this development evidences little synergy with the scenario of mass tourism.

Scenario A: Urban form



Scenario A: Mobility



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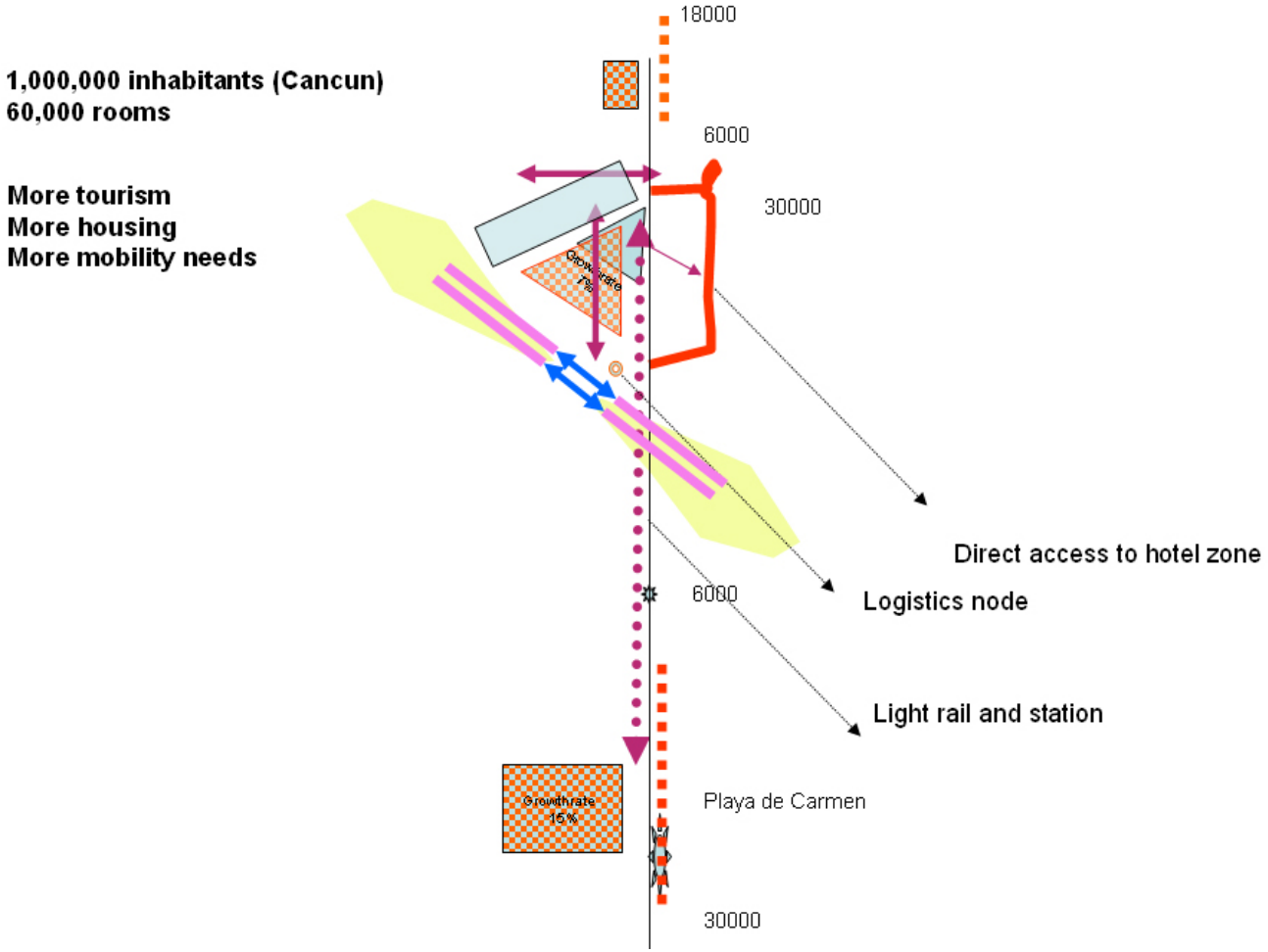
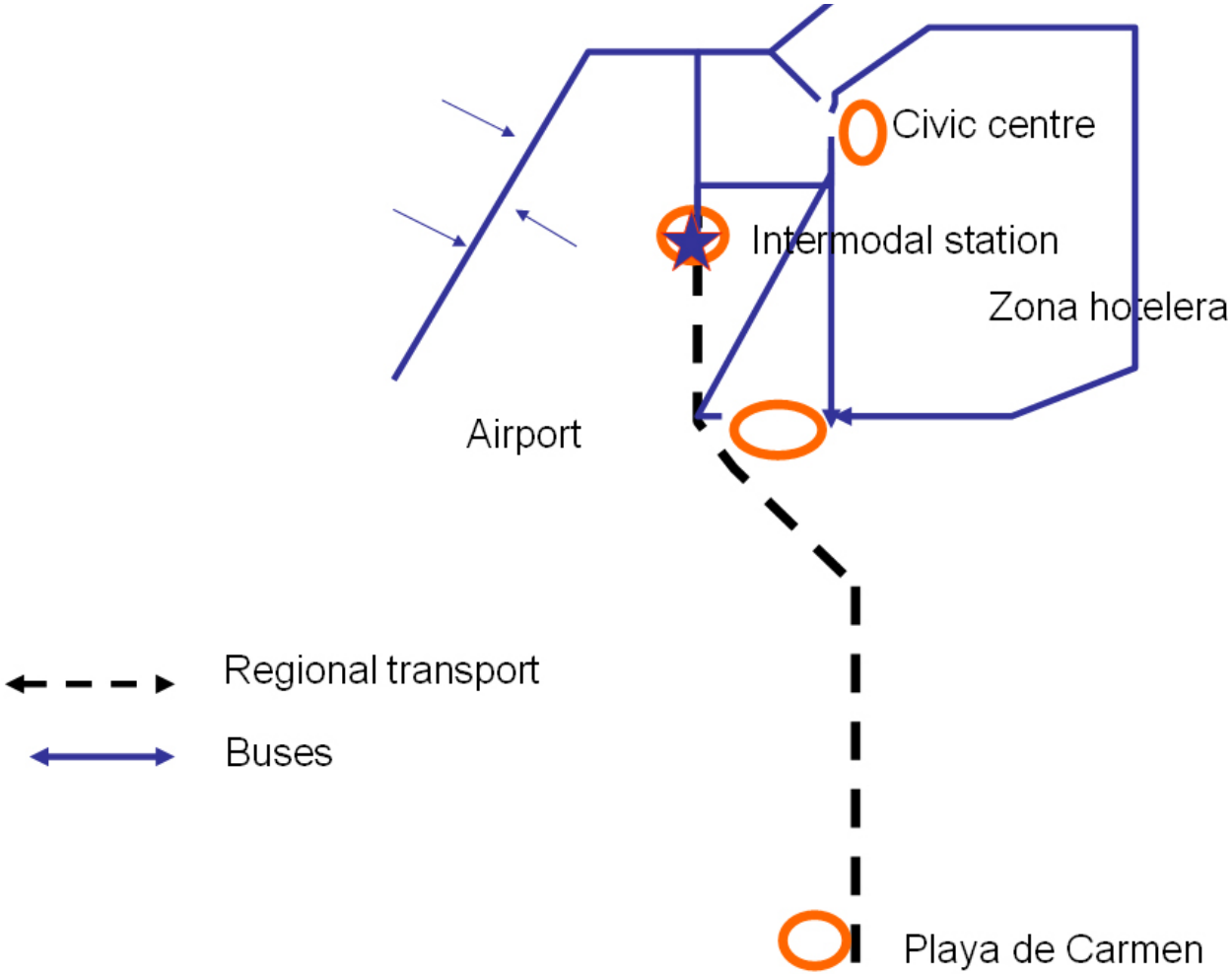
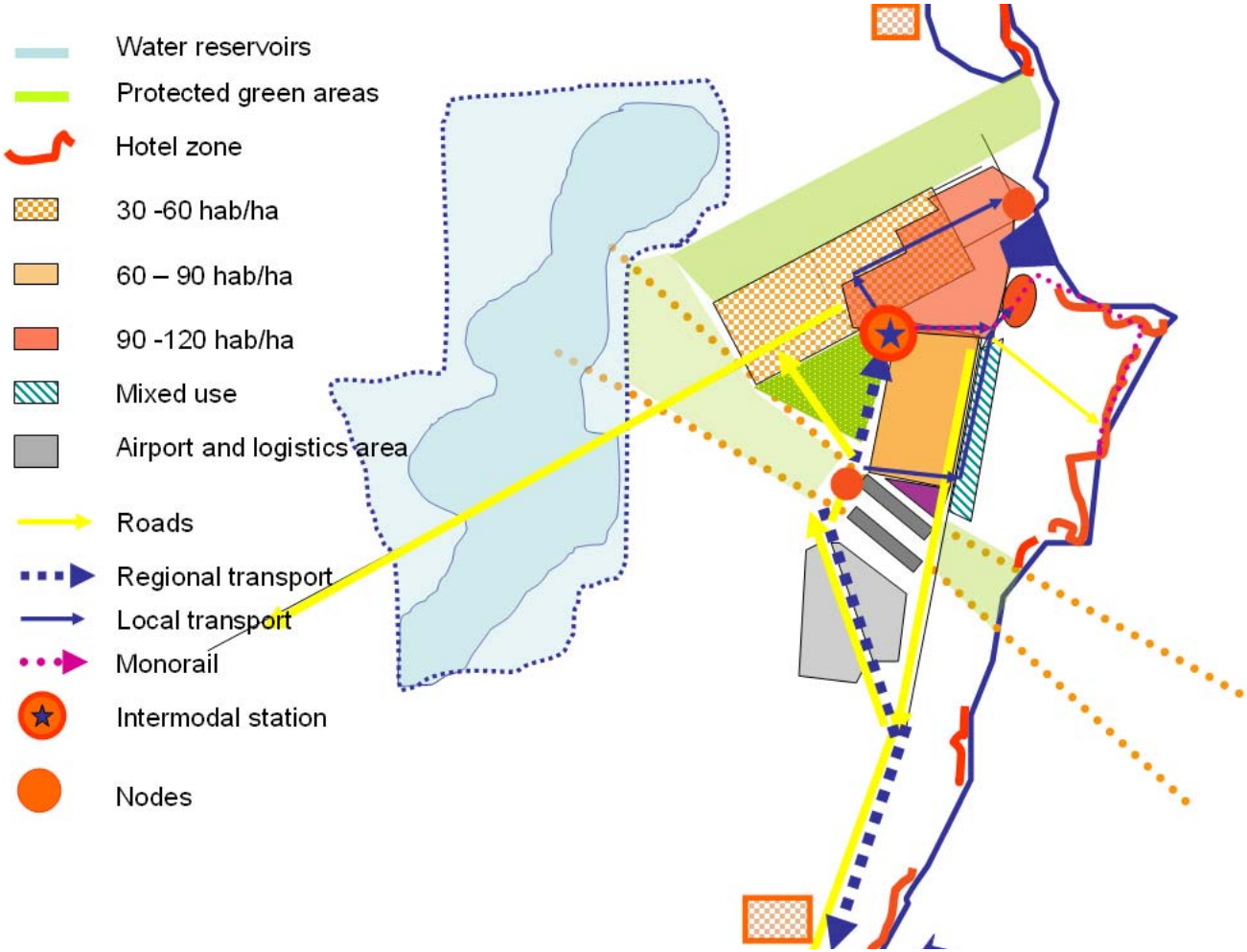


Scenario A: Transport

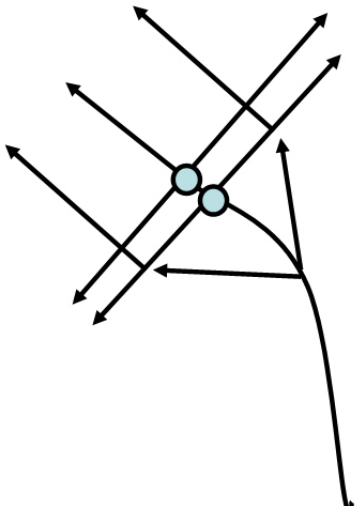


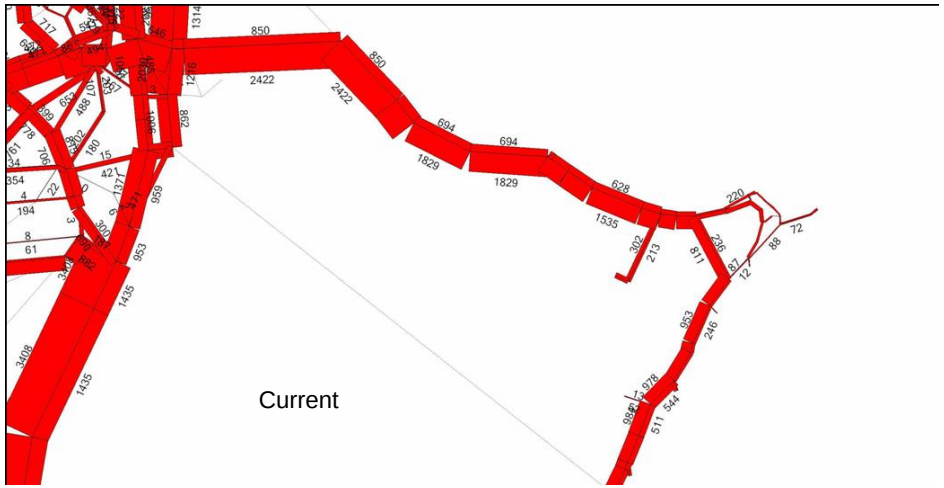
Scenario A: Land use

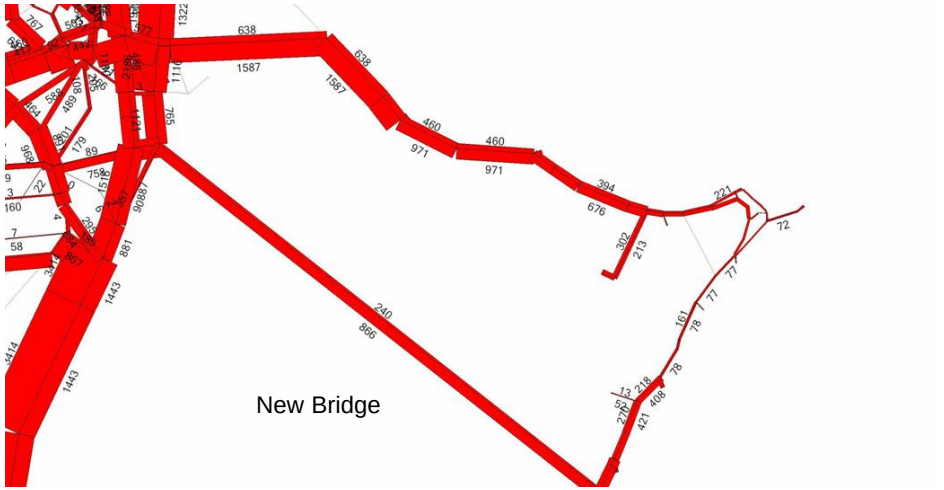


Scenario A: A new bridge?

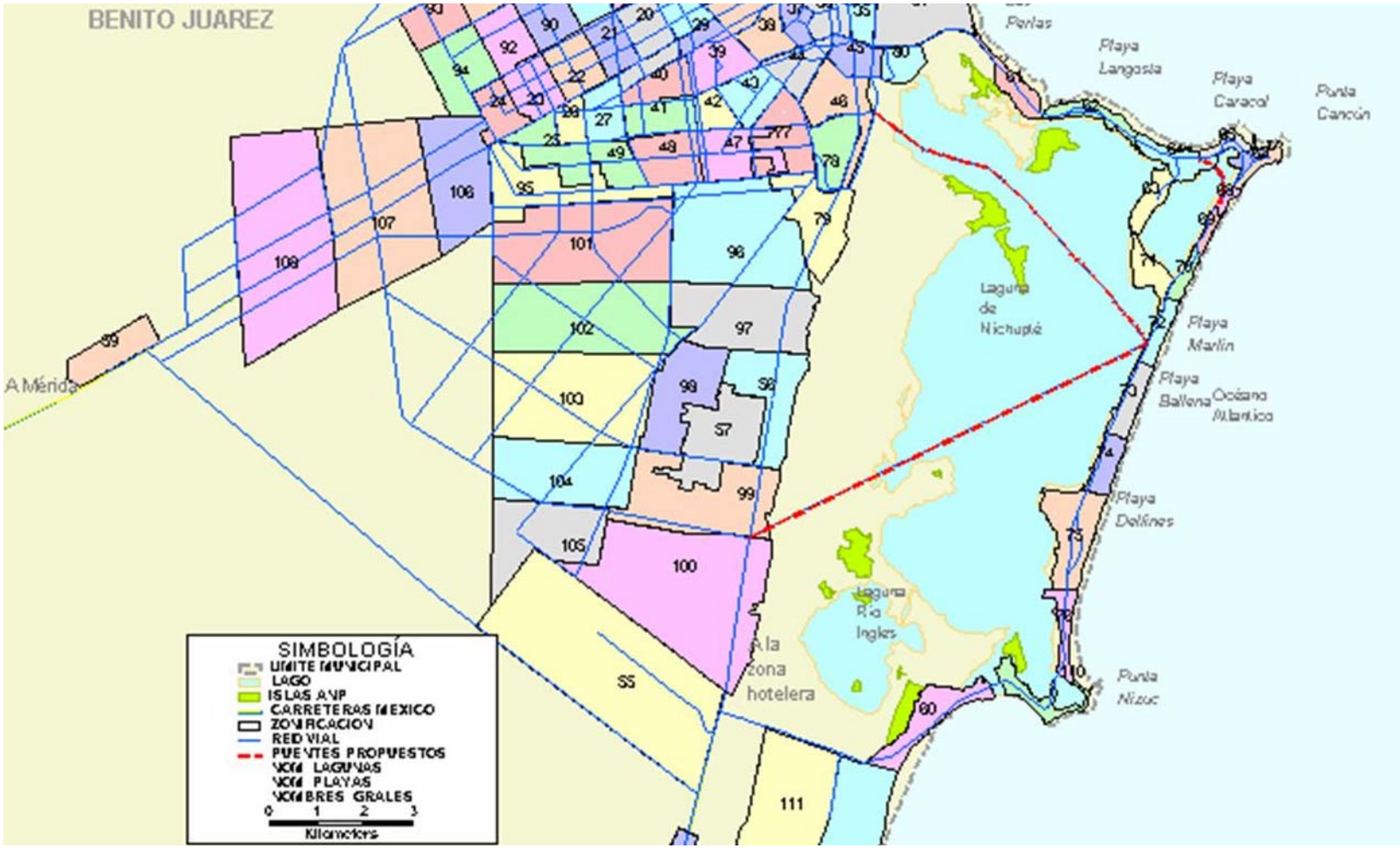
The local government is evaluating the benefits of constructing a bridge across the Nichupte lagoon. Two possible layouts over the lagoon are being considered. An analysis of traffic volume showing the current status and the situation after the construction of the bridge do not show a significant difference in the Boulevard Kukulkan segment, and the congestion in the East end on the boulevard is still remarkable. This suggests that broadening the boulevard with a bridge is less important than solving the intersection at the end of the Boulevard, and hence, the bridge will not solve congestion.







Scenario A: Possible location of government-proposed bridge



Scenario B: "Ciudad Central"

This scenario sees Cancun develop as a leading commercial and service centre serving its surrounding region and a larger influence zone in Yucatan and the Caribbean. The tourism industry will be retained, but the main source of employment would be in service related jobs.

The model will require a remarkable transformation in the accommodation stock, from hotel rooms to condominiums in order to provide housing for professionals moving in. In addition, hospitals, schools, and other support facilities need to be upgraded or built from scratch. As much as the investment in infrastructure such as roads and airports is critical, so is a high expenditure in education and cultural activities to both attract and prepare professionals.

To fulfil the growth perspective foreseen in this Scenario, urban development will need to be carefully planned including a series of catalytic projects. Specifically, these comprise the site of the new civic centre in Malecon and the creation of three major corridors in addition to the Hotel Zone.

1. Via Lopez Portillo Corridor: A mixed use district with an emphasis on small commercial/service developments that serve both local residents and the building industry in the Hotel Zone.

2. Libramiento Merida -Playa del Carmen Corridor: An industrial district intended to serve the import-export activities of the region with relevant trade/logistics components and infrastructure.

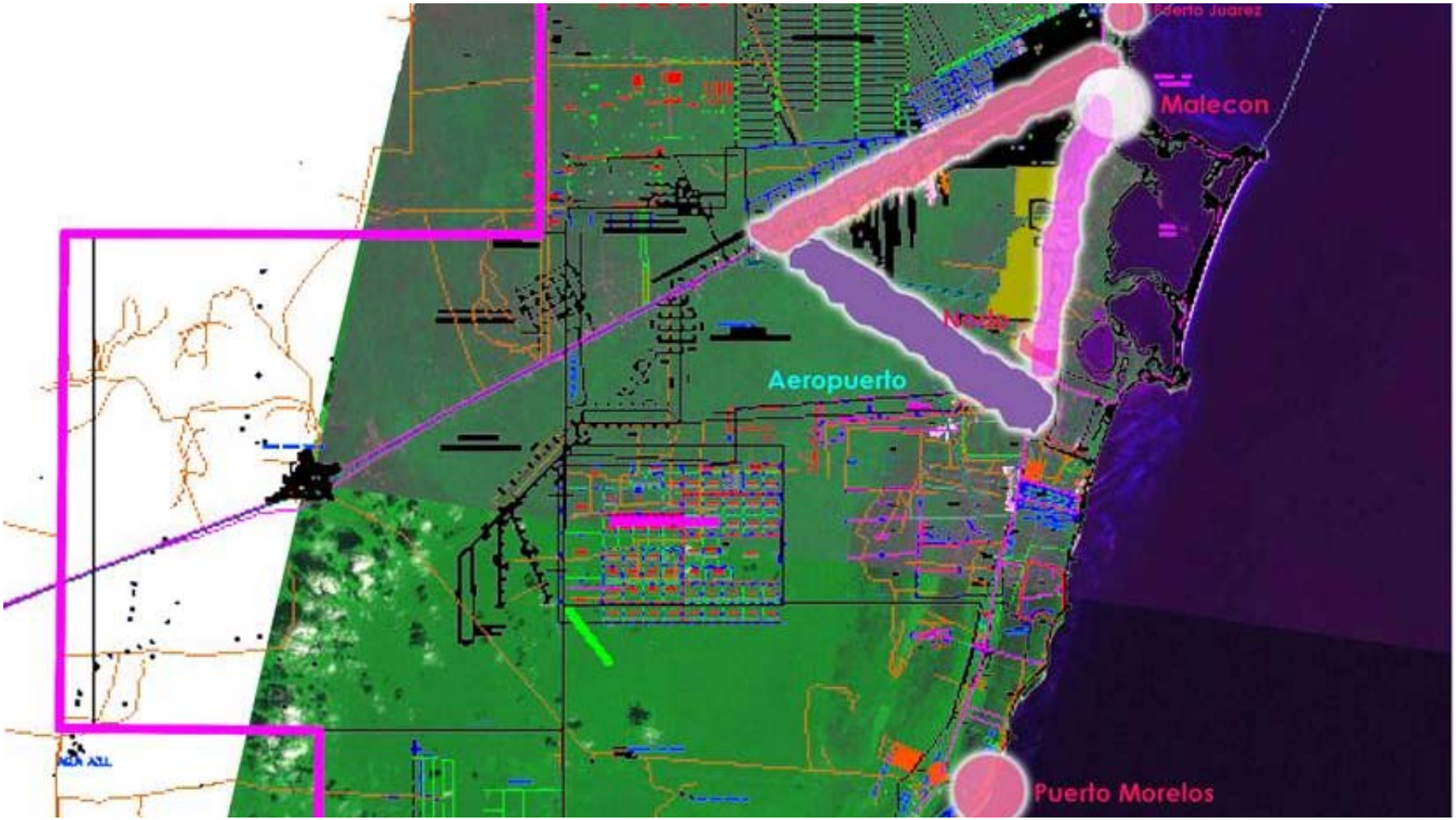
3. Cancun-Puerto Morelos Corridor: A Regional District that would contain a myriad of corporate headquarters and professional offices, major health facilities, universities and specialised services. The international airport becomes an important node for commerce as well as tourism, and the two ports are to be developed as potential doors to the Caribbean. Somewhat like San Diego, California, this balanced economic scenario necessitates a new vision for future demographics and investment.

Future urban development is structured in three distinctive axes: between the airport and the city centre, along the extension of the highway going westwards, and a bypass between the two main highways, connecting the airport and creating a compact, triangular urban lay out.

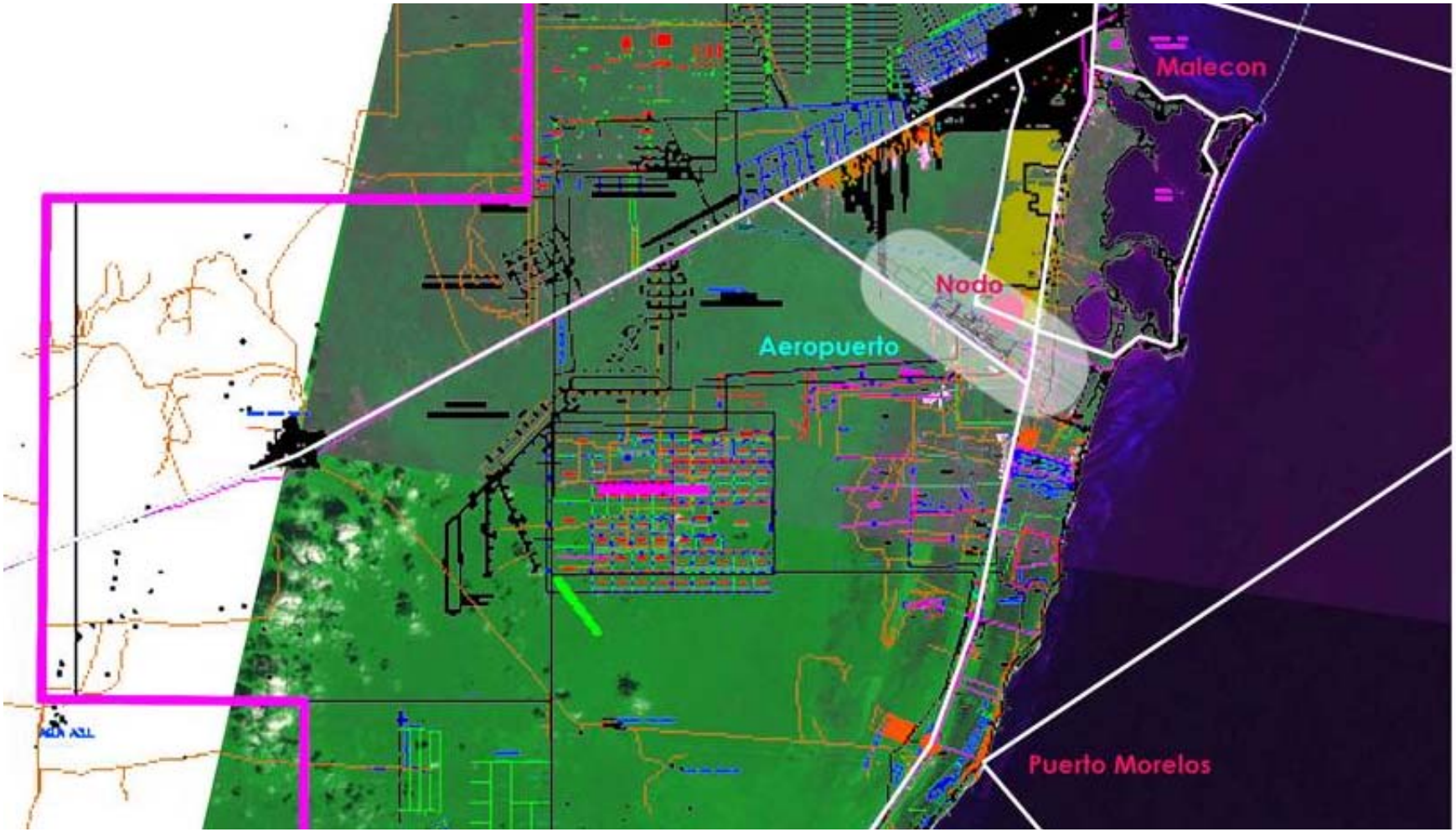
These new city strips induce increase of urban density within the existing city grid. The distinctive urban areas express a variety of programmatic clusters that represent a diversification of economic activity. In general terms, the Western Corridor acts as a small scale yet regional production and service area, the Southern Corridor as a more extensive industrial zone specialised on transport and value added logistics, taking advantage of the proximity of a relatively well equipped airport. The East Corridor will feature a cluster of universities, research, technology services and government institutions. The model banks on the quality of landscape and climate in attracting highly educated human recourses from all over the world.

The Scenario assumes a diversification of economical activities in the city itself, an efficient infrastructure network that is highly based on connectivity and a strengthening of social networks between management, knowledge, technology and production. It is proposed that the existing bus service be complemented by a light rail system.

Scenario B: Urban form



Scenario B: Mobility



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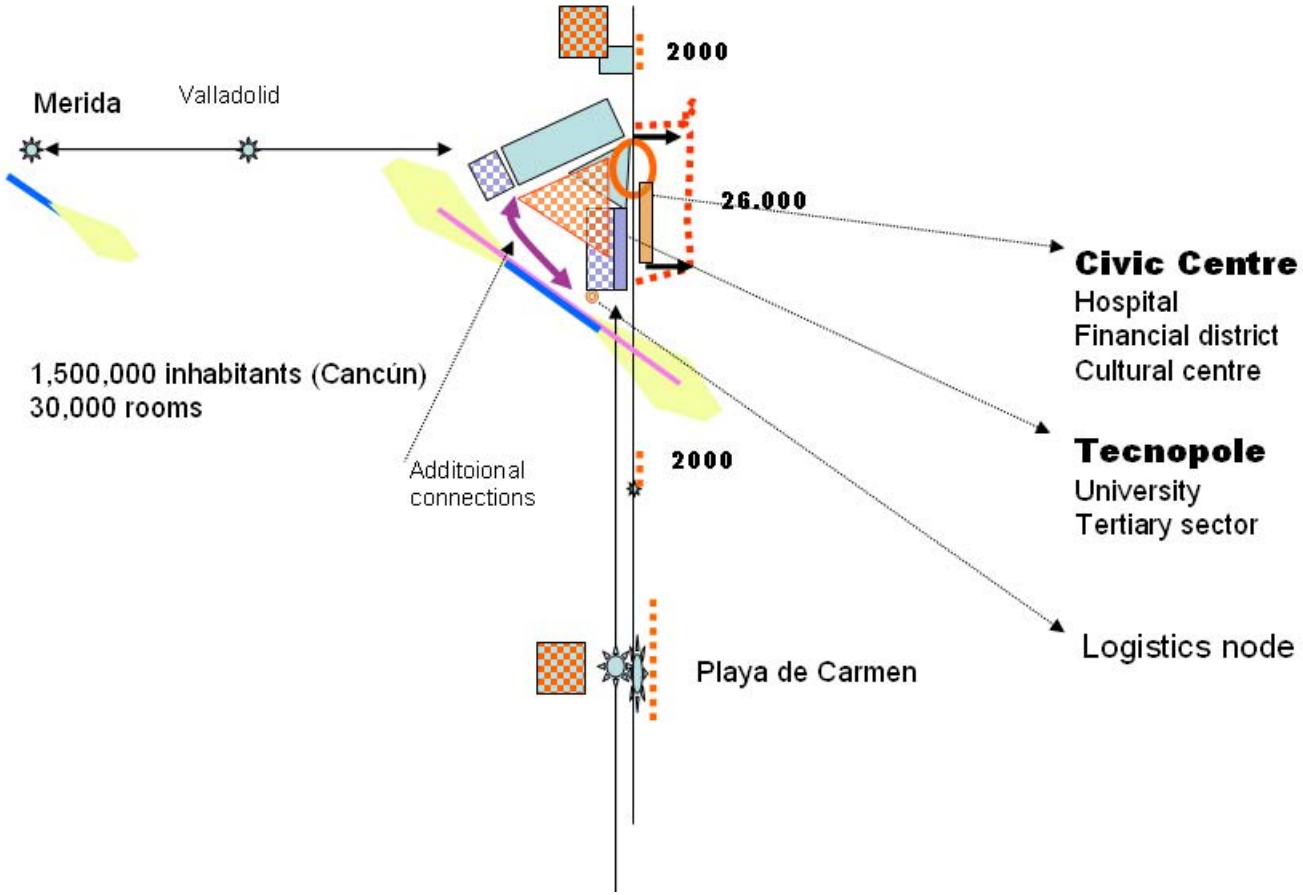
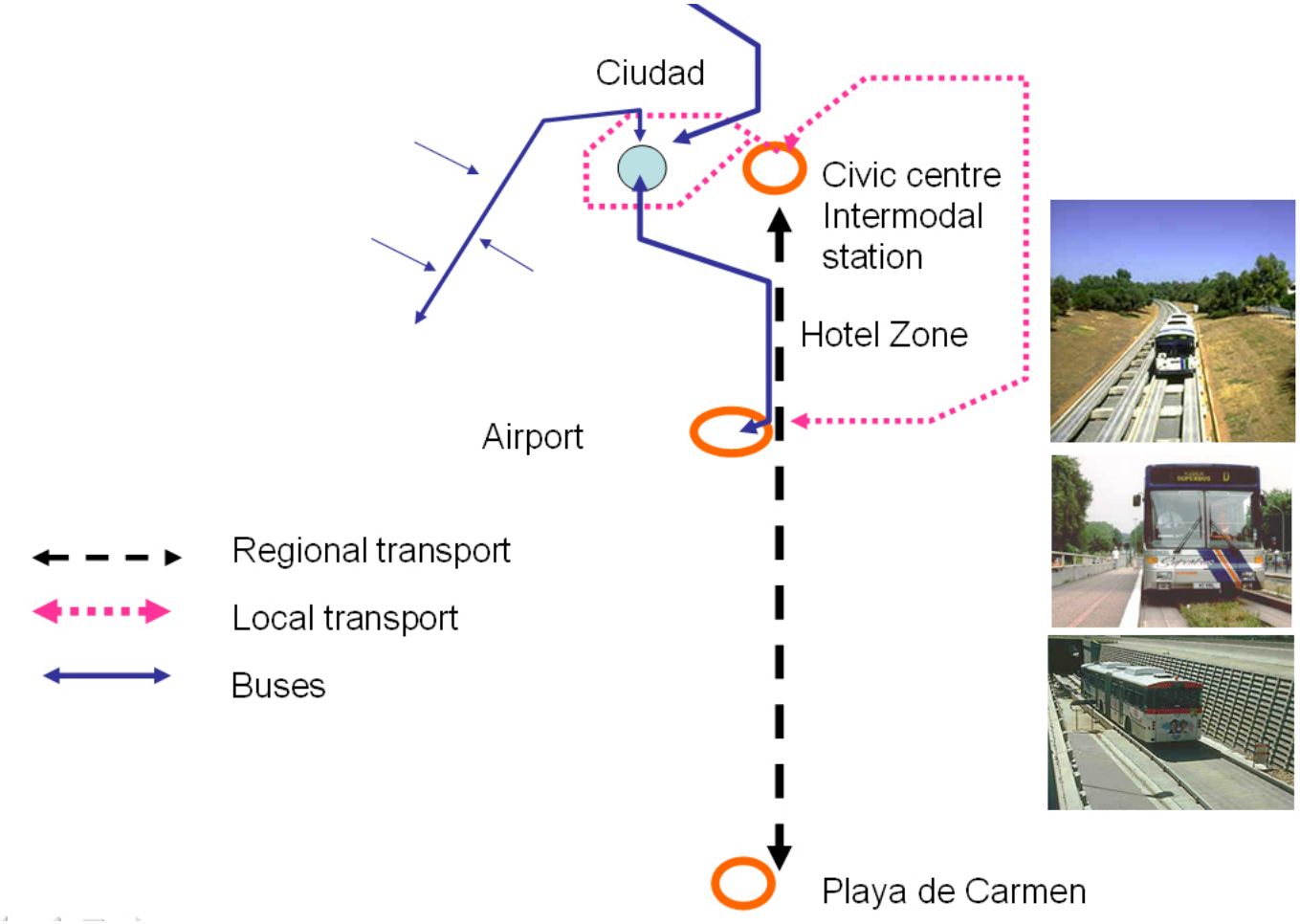
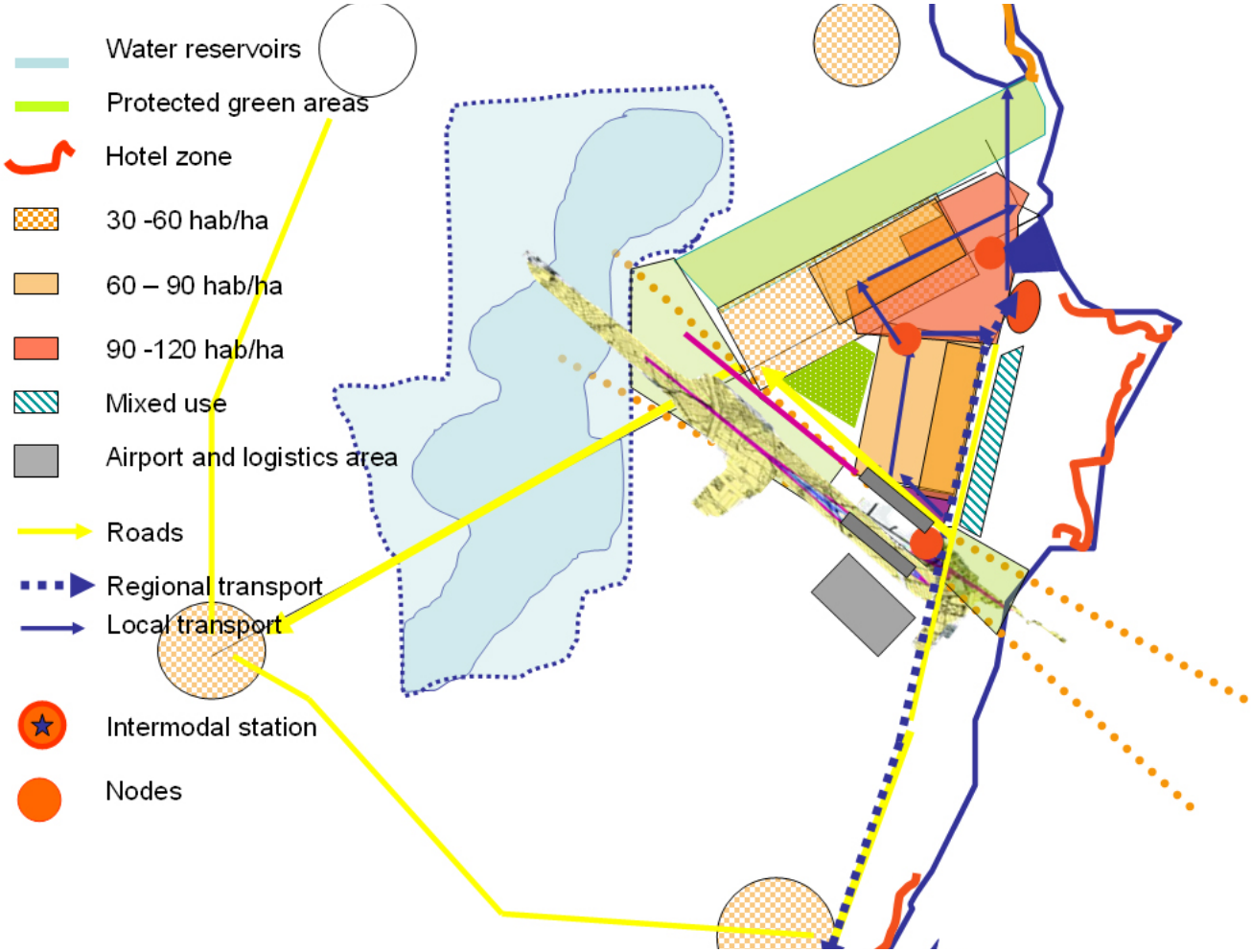


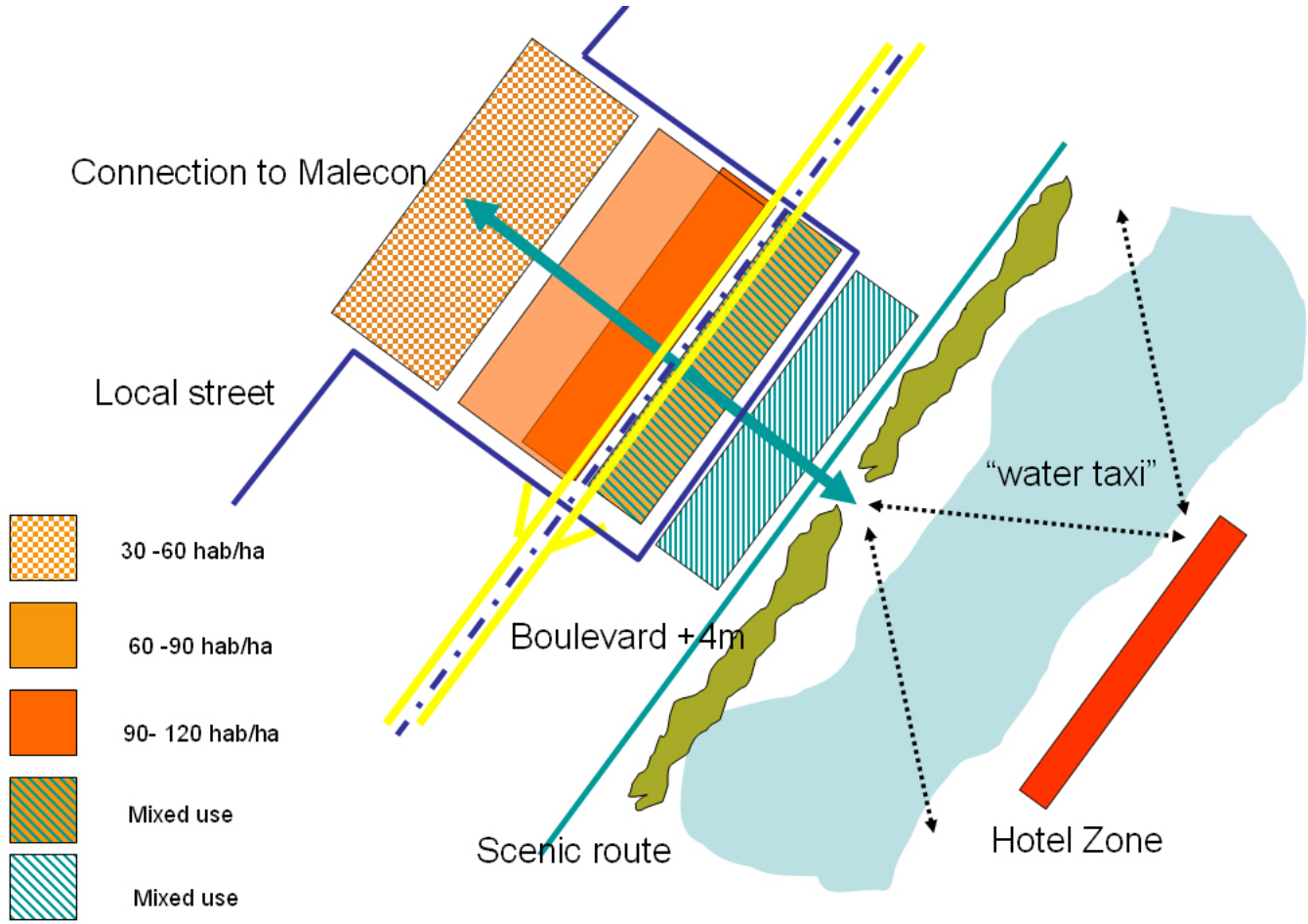
Scenario B: Transport



Scenario B: land use



Scenario B: Section at Boulevard Colosio and lagoon



Scenario C: "Ciudad de Comunidades"

The "City of Communities" model would place emphasis on preserving the environmental quality or the region and the redevelopment of a number of communities within the region, such as Puerto Juarez and Puerto Morelos which have grown organically around small ports to the north and south on the Cancun city proper.

Tourism would continue to be a primary economic driver, but its territorial footprint will show a dispersed arrangement which peaks marking these communities as well as other attractors such as the cenotes (immense, deep, open wells) located to the southwest of Cancun.

With some similarity to the smaller-scale development of Oregon or New England coastlines, this model would decentralise the tourism economy. It would also facilitate opportunities for more diverse tourism experiences and support ecotourism development at the cenotes and coastal villages

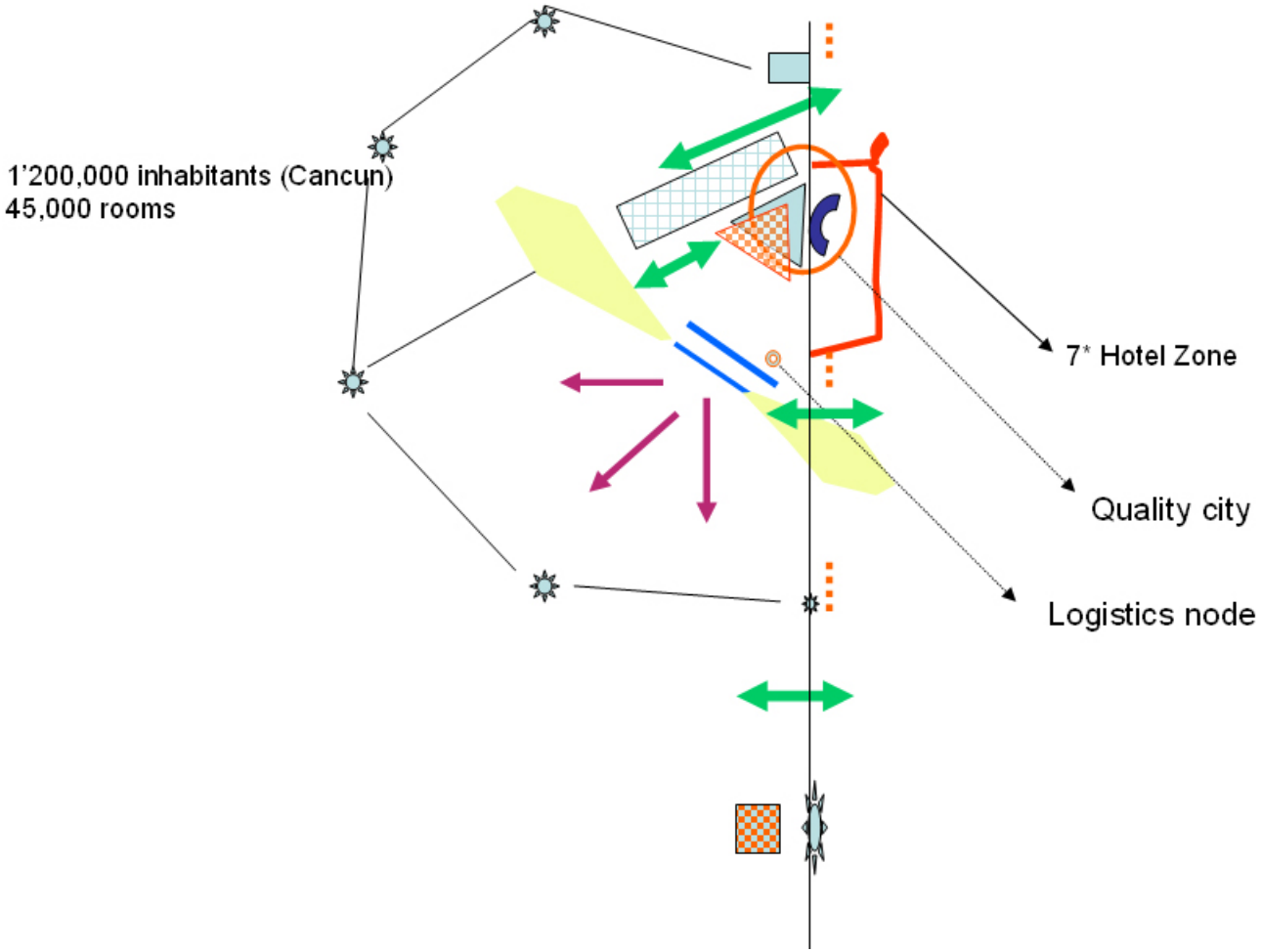
In many ways, this scenario is the opposite of Scenario A: tourism is scattered around in a much bigger area along the Mexican Riviera. Small communities of high quality tourist compounds are imbedded in the natural beauty of the landscape. For the demanding tourists, it provides a sense of privacy, almost a thematic approach, which might as well be one of the unique selling points of the region. At the same time, the relative separation of the contained settlements makes it possible to diversify the tourism opportunities. The sprawl of the communities can be seen as an archipelago of different experiences, there's something to chose.

To reduce daily commuting, each village is to be accompanied by housing facilities for local inhabitants that work in the tourist industry. The small scale in the mix of locals and tourists could even be one of the attractions of the vacation (authentic informality).The sprawl of small communities makes it possible that the ecological green zones function like a whole; the urban settlements are just 'plug-ins'. Normally, such lay outs cause negative effects on the environment because of increased mobility. To prevent this, the communities should have an autarchic (self-sufficient) character: Cancun as the city of villages.

Scenario C: Land use

Scenario B: Mobility

Scenario C: Transport



Summary of Scenarios

Summary	Scenario A
2030 Population	1,500,000
Identity	Globalised
Nodes	Isla Cancun—Zona Hotelera
Districts	Zona Hotelera
Landmarks	Hotels
Limits	Sea, lagoon, airport
Axis	Hotels-Airport Corridor New Bridge over Nichupté Lagoon

Summary	Scenario B
2030 Population	2,000,000
Identity	Cosmopolitan
Nodes	Malecon – Airport Corridor
Districts	Airport Corridor, Hotel Zone, Ejidos
Landmarks	Malecon
Limits	Sea, lagoon, airport
Axis	Malecón-Aeropuerto-Puerto Morelos Libramiento - Carretera Mérida-Puerto Morelos José L. Portillo

Summary	Scenario C
2030 Population	1,500,000
Identity	Mexican Caribbean
Nodes	Malecón, Isla Cancun, Puerto Morelos, Puerto Juárez
Districts	Zona Hotelera, Puerto Morelos, Ejidos, Ruta de los Cenotes
Landmarks	Malecon
Limits	Sea, lagoon, airport
Axis	Malecón-Aeropuerto-Puerto Morelos Libramiento - Carretera Mérida-Puerto Morelos José L. Portillo

New urban development

Scenario A

Scenario B

Scenario C

Tourism Planning

It is relevant to mention that the tourism industry in Cancun will be an enduring element in city planning. Therefore it is to be noted that the tourism supply and demand economics for tourism dictate specific planning requirements. On the supply side, tourism destinations must have five essential components:

1. Attractors - Cancun has numerous attractors that include sunny tropical weather, beaches, surf and sea, cenotes, and close proximity to many archaeological sites. Preservation and enhancement of these attractors should be a tourism planning priority.

2. Infrastructure - Access and accommodation are key components. In particular, the airport establishes the first "sense of arrival" setting the stage for the tourism experience. Improved public transportation ensures visitor travel to broaden the economic benefits.

3. Services - Integrated services (as in land use) is fundamental to expanding tourism.

4. Information - This element includes signage (symbols preferred over translation), website(s), kiosks, and for many public spaces, a visible information officer.

5. Promotion - Advertising, news media, websites, publication, and all kinds of promotional activities/events should keep Cancun in the hearts and minds of international travellers.

Environmental assessment

The following evaluations have been prepared to allow stakeholders in the Cancun region to compare the impacts of the alternative development scenarios on the environmental and their relative resistance to the destructive forces of hurricanes. The accuracy of assessment is limited by the general nature of the assumptions and information used, so the analysis operates only with qualitative estimates which are meaningful solely for comparison purposes.

The analysis has been presented in the form of matrices. For each alternative the following plan components have been assessed: hotel zone, urban shape (city of Cancun), development of the other settlements within Benito Juarez municipality, mobility (understood as flows of people and goods as well as means of their transportation), airport and public utilities (excluding transportation).

The environmental impact matrix compares both environmental and quality of life issues. The environmental features assessed are: Nichupté lagoon; mangrove areas along the coast (south of Cancun); forest systems; and finally, reef/beaches. The quality of life issues examined include water resources; noise level; air quality; and urban greenery /landscaping. The overall matrix shows the impact of each component within each scenario on each of the environmental and quality life variables. The classical environmental impact matrix analyses separately its magnitude and importance but due to the general form of scenarios this impact estimation is limited to a four grade scale of effects: adverse; less adverse; neutral; and favourable.

The matrix estimating the potential hurricane impact uses three variables - the principal detrimental factors of the hurricane: high-speed wind; rain flooding; and, storm surge. The impact strength is estimated within a three-grade scale: from the least to the most serious potential damage (or from the most to the least resistant item).

Scenarios and their environmental impact

Although the overall impact of all scenarios (measured by the number of filled matrix cells for each of them) can be considered as similar, it should be pointed out that its differing plan elements are affected differently in each scenario.

Scenario A shows the greatest number of adverse environmental effects. Further and intensive development of the hotel zone around the lagoon, and the possibility of creating a new bridge across it, threaten the fragile ecosystem. It will also exploit most intensively the beach on Cancun's Zona Hotelera. The transport of tourists, if still by buses and taxis, will adversely affect the acoustic and air quality. Both hotel and municipal growth will increase the demand for water supply and public utilities. A second landing strip for the airport will be needed and its construction will result in loss of forest and increased noise, which will have a negative effect on fauna in the surrounding zone. Growth of mobility between the city, airport and Riviera Maya as well as within the sprawling area of the city itself will produce great volumes of air pollution and high level of noise. Lower emphasis on the development of the other settlements within the municipality will have less adverse environmental impact.

In Scenario B the development impact lessens on the lagoon (it is assumed to receive a nature conservation area status) and beach but increases on the forest as the city will need to grow, despite the higher densities. The territorial expansion can threaten the aquifer zone, which supplies the

Cancun's drinking water. The problem of worsening the life quality within the city will be similar to the scenario A.

In scenario C the environmental impact of the development is generally less strong than in the other scenarios (in the hotel zone even the favourable effects can be expected) but it affects a much greater area. The pattern of dispersed tourism will affect above all the natural areas south of Cancun - the mangroves, forest, reef and beaches although probably not so badly as in the scenario A. The necessary mobility increase will still have strong effect on the quality of life.

Impact on environmental factors

Factors related to quality of life (especially the levels of noise and air quality) are most strongly threatened by the developmental forces within all scenarios. The adverse effects

Effect on	Environmental variables				Factors of the life quality			
	Lagoon	Man-groves	Forest	Reef/ beach	Water re-sources	Noise	Air quality	Urban greenery
Scenario A								
Hotel zone								
Urban shape								
Other settlements								
Mobility								
Airport								
Urban utilities								
Scenario B								
Hotel zone								
Urban shape								
Other settlements								
Mobility								
Airport								
Urban utilities								
Scenario C								
Hotel zone								
Urban shape								
Other settlements								
Mobility								
Airport								
Urban utilities								

accumulate also on the lagoon in the Scenario A, the forest in Scenarios A and B and all environmental variables outside the city in the Scenario C.

An analysis of the hurricane impact matrix shows that the biggest potential damage should be expected within the Scenario A due to the concentration of growth adjacent to the ocean. Among devastating hurricane powers, the strong winds and flooding can affect the whole area of Benito Juarez municipality while only the coastal strip is prone to the storm surge. From this point of view Scenarios A and C, developing tourist activities in this area, are almost equally little resistant in the case of the next hurricane. The potentiality of damage from flooding depends on the size of the surface prone to such disaster so it is the greatest in the Scenario B, what results from increase in the built-up area and possibility of affecting the greater utilities network.

Potental damage	Wind	Flooding	Storm surge
Scenario A			
Hotel zone			
Urban shape			
Other settlements			
Mobility			
Airport			
Urban utilities			
Scenario B			
Hotel zone			
Urban shape			
Other settlements			
Mobility			
Airport			
Urban utilities			
Scenario C			
Hotel zone			
Urban shape			
Other settlements			
Mobility			
Airport			
Urban utilities			

Hurricane Wilma

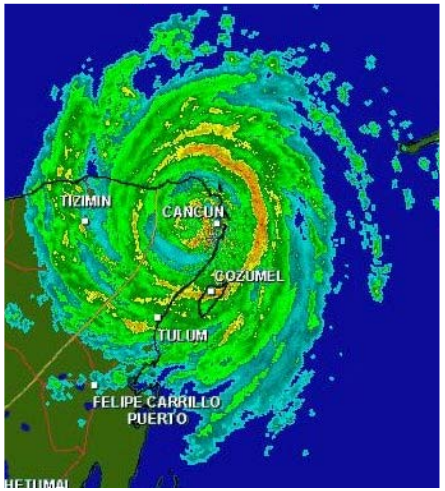
A brief history of Hurricane Wilma

On October 14, 2005, a large monsoon-like system over the entire Caribbean and an upper level cyclone over the southwest Atlantic spawned a low pressure disturbance near Jamaica. By October 15th, the storm was designated a tropical depression centered 190 nautical miles east-southeast of Grand Cayman Island. Moving slowly and erratically westward, the storm slowly strengthened and was designated tropical storm Wilma on 17 October. Then turning northward, on 18 October, the growing storm was designated a hurricane, and within a few hours Wilma underwent the most remarkable intensification ever recorded. Between 11PM UTF on 18 October and 5AM UTF on 19 October the sustained wind speed increased from 109 MPH to an amazing 172 MPH, peaking 3 hours later at 175 MPH over open water.

According to the official 'report[1]' issued by the NOAA National Hurricane Center: "In a span of just 24 hours, Wilma had intensified from a 60 kt[2] tropical storm to a 150 kt category 5 hurricane, an unprecedented event for Atlantic cyclones…During the strengthening episode, Air Force reconnaissance observations indicated that the eye of the storm contracted to a diameter of 2 n mi[3]; this is the smallest eye known to National Hurricane Center staff."[4]

Fortunately, this extremely violent category 5 storm abated somewhat due to the effect of other weather systems over the Gulf of Mexico. Then, it turned northward and at 2145 UTC October 21st, the eye of this strong category 4 storm made land fall on Cozumel Island. Six hours later the hurricane center crossed to the coast of the Yucatan Peninsula, in the vicinity of Puerto Morelos.

Overland, it quickly lost some of its power, dropping first to a category 3 and finally to a category 2, still a large and powerful hurricane, before passing northward and out Mexico early on 23 October. Illustration 1 shows the track of the storm and its maximum wind speed as it crossed over Mexico.



Although Wilma's intensity weakened once inland, the storm had been undergoing a cycle of eyewall replacement prior to making landfall and had formed a double eyewall structure that was clearly visible on local radar. This unusual structure (not illustrated in the following discussions of wind) subjected the coast of Quintana Roo to four eyewall passes rather than the normal two and led to a doubling in size of the area affected by the hurricane force winds[5].

1 Pasch, Richard J., Blake, Eric S., Cobb III, Hugh, D. and Roberts, David ,P., "Tropical Cyclone Report, Hurricane Wilma, 15 - 25 October 2005", NOAA National Hurricane Center, 12 January 2006.
2 Kt = knots. 1 knot = 1.15 Miles per hour = 1.852 Kilometers per hour
3 nautical miles. A nautical mile = 1 knot
4 Ibid. Page 1

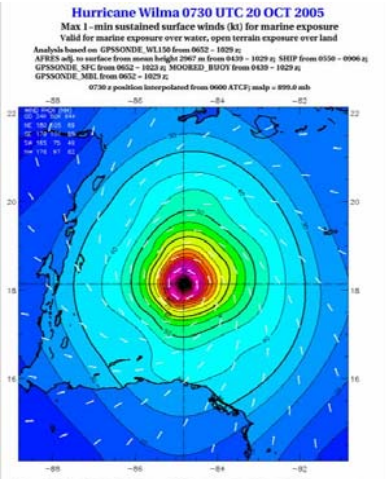
5 National HurricaneCenter release 11 PM EDT SAT OCT 22 2005
THE CENTER OF WILMA HAS MOVED OFF OF THE NORTHEASTERN COAST OF THE YUCATAN PENINSULA....
THE PLANE ALSO REPORTED THE REMAINS OF AN INNER EYEWALL...AND AN OUTER EYEWALL WITH A DIAMETER VARYING BETWEEN 60-80 N MI. WILMA IS CURRENTLY TRYING TO FINISH AN EYEWALL REPLACEMENT CYCLE THAT BEGAN ALMOST 48 HR AGO....

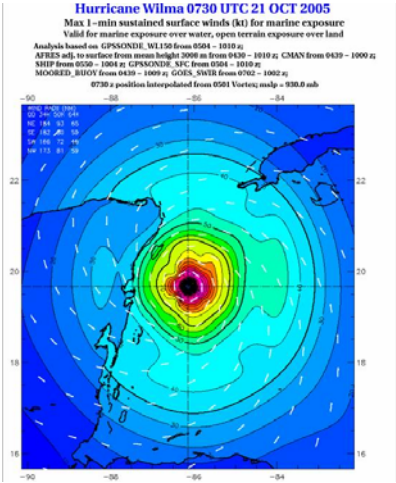
Hurricane Damage Mechanisms

There are three forces that cause the damage from hurricanes:

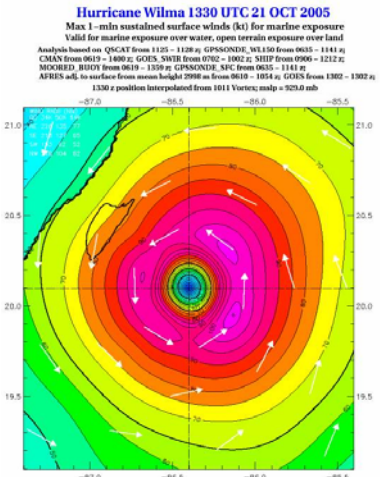
1. Wind;
2. Waves; and,
3. Flooding.

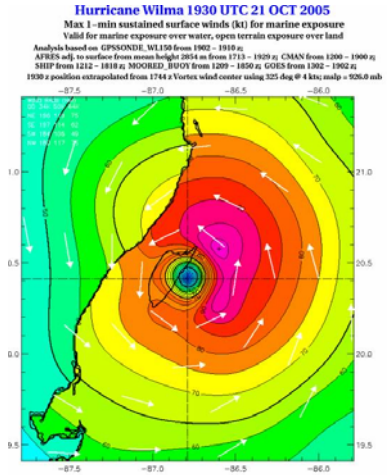
Wind - The flowing diagrams produced by the United States National Oceanographic and Atmospheric Administration (NOAA) display wind direction and intensity at various times during Wilma's page through Mexico.



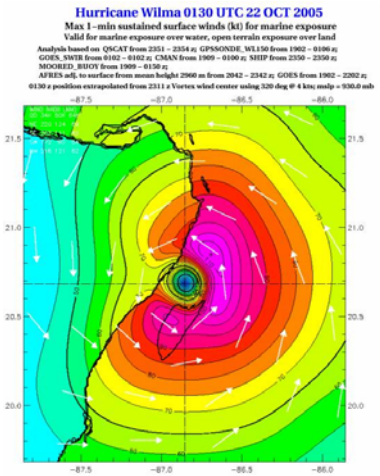


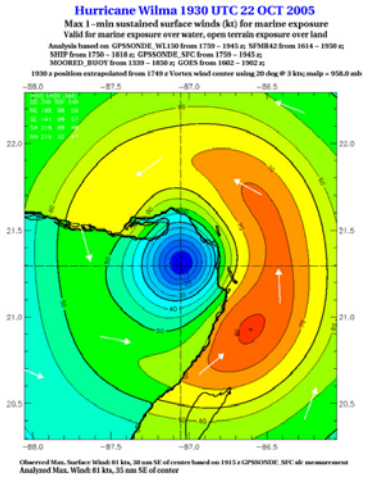
These views illustrate Wilma approaching Cozumel and the Yucatan Peninsula. At the time of the first illustration, on October 20th, the winds near the center of this category 4 hurricane were sustained at 149 miles per hour (MPH). North-northeast breezes of 20 mph were felt in the Cancun region. However, a day later, as the 145 mph category 4 hurricane approached Cozumel, winds had picked up near Cancun to 45 mph coming from the north.



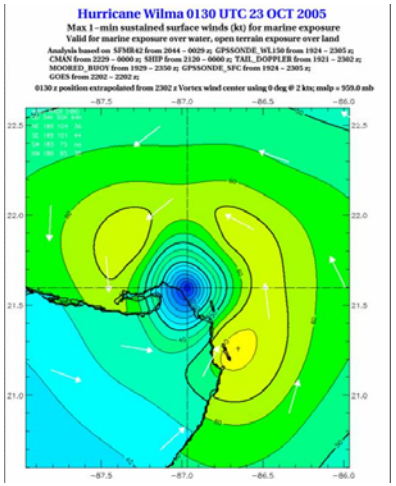


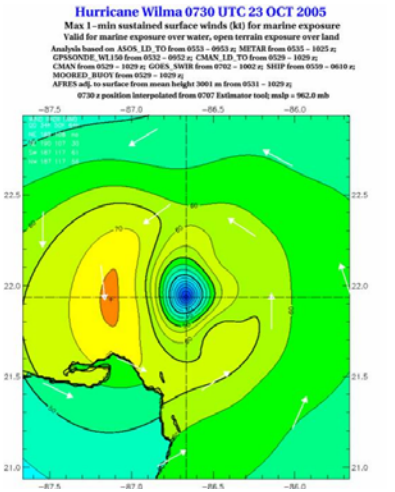
In diagrams W2 and W3, the wind direction shifts to the east and intensifies to 85 mph, as the hurricane approaches and then begins to cross Cozumel Island.





Diagrams W5& 6 show the hurricane passing through the Peninsula. Because the storm begans to pass over a substantial landmass and it lost its source of energy (heat from the ocean), and lessened from a Category 4 storm to a Category 2 event - still a large and dangerous storm. Sustained winds near the center of the storm dropped from 135 mph to 100 mph. Diagram W5 illustrates the period of time when Cancun received its highest winds and its most severe damage. Sustained winds from the east-southeast approached 100 mdp and gusts likely reached 119 mph. Eighteen hours later the storm had passed south of the city and then up the peninsula to the east of Cancun, which was now only buffeted by 50 MPH south southeast winds.

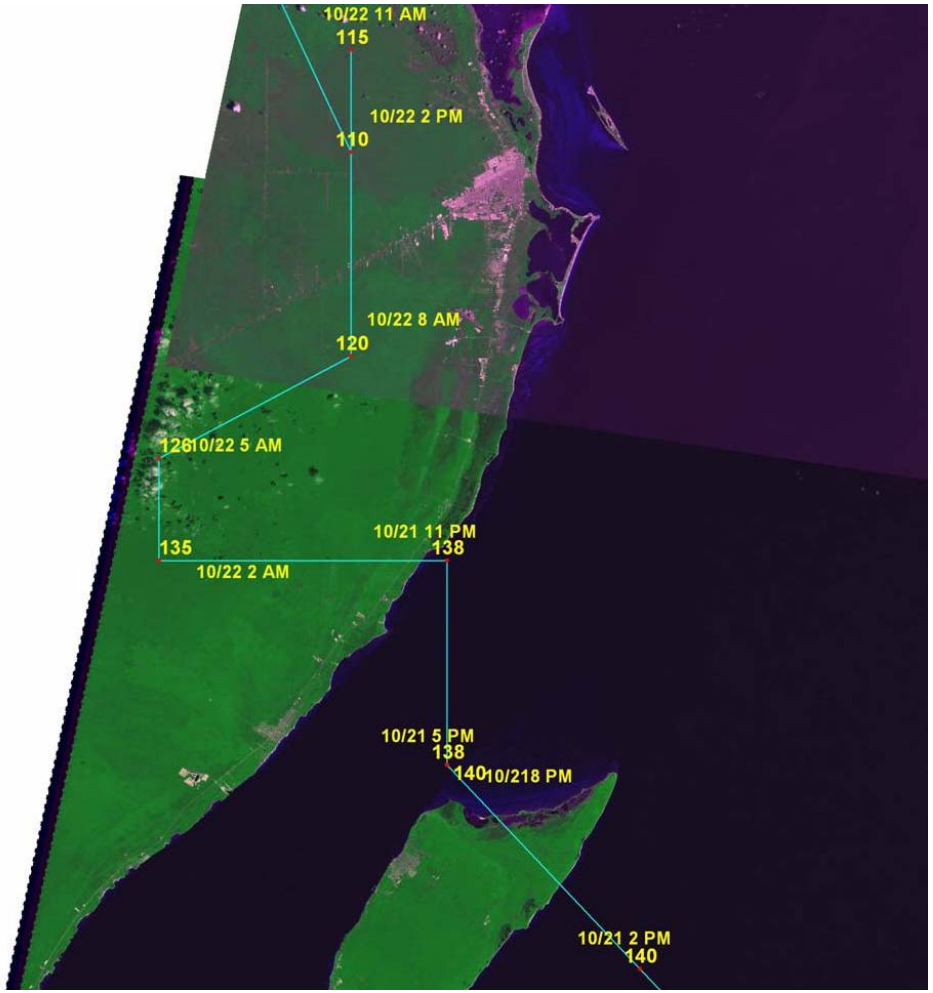




Finally on 23 October the hurricane enters the Gulf of Mexico and headed northward, not to return. Winds during this period continued to be south southeasterly and gradually declined from to 45 mph, as shown in W8.

Wind damage can be from debris or from structural failure induced by the wind itself. "It is relatively rare for glass or other components of the cladding to fail under the action of wind alone"[6] according to reports. However there was an enormous amount of glass broken during Wilma, likely caused by wind-borne debris. Once the building shell is violated, water damage is inevitable and even structural failure can result as wind enters the structure and can cause a cascade of interior door and even wall failures. Most studies of glass damage identify roofing gravel as a main cause of the damage[7]. However it is possible that beach sand and gravel did much of the damage to the oceanfront hotel properties.

Branches, wood and landscape materials also can become dangerous projectiles during hurricanes; a coconut is reported to have penetrated a window and then an interior wall of house near Puerto Morelos, as if shot from a cannon. Roofs and signs are especially prone to wind induced failure. Roofs tear off and signs and various outdoor standards bend and break. Wind damage is responsible for most electrical service failures during a storm. Landscape materials also are blown over by the wind. In fact landscape damage is such a reliable predictor of storm intensity that it is one of the metrics used to categorize hurricanes on the Saffir- Simpsons scale.



6 Ibid. cochran page
7 see: http://www.wbdg.org/design/env_wind.php

Waves - There are three types of wave damage: storm surge; overwash and beach transport. Surge is water pushed by the force of the storm. In fact there are five processes which act on storm surge: "pressure effect, the direct wind effect, the effect of the earth's rotation, the effect of waves, and the rainfall effect" . Of these processes, the most influential are pressure and wind. The extremely low pressure found in Wilma's center pulled water higher near the center of the storm so, as the center of the storm approached the coastline, the water in the ocean and its waves were higher. In addition the friction of the waves piled the water up, and as seen in the preceeding diagrams Wilma produced very high winds. Wind direction also pushes waves higher, an effect termed 'wind set-up', so that waves are higher downwind and lower at upwind locations. If we refer back to diagram W5, we can imagine the surge hitting the Cancun region. The storm center was near by, so the water levels were lifted by the lower barimetric pressure, the winds were at their peak in the area of Cancun picking up more water into waves and the shape of the purple isobars in the diagram illustrates that wind set up must have been pushing the surge waves higher yet.

The slope of the seabed near the shore greatly influences the amount of damage on the shore from waves. If the seabed approach to the shore is deep, there is less friction and the waves do not build up. The Seabed along the Yucatan Peninsula is shallow, characterized by a gentle rise approaching the shore. With this seabed condition, surge builds into large powerful waves, with the potential for great damage to structures near the shore. Mitigating this situation are offshore reefs, which allow waves to break, losing much of their power. Off the barrier island at Cancun, there are no reefs - the waves build and roll in unabated. But south of Cancun, the offshore reefs protect shore properties.

Overwash is the term for wave-driven seawater that flows over low areas along the coast and floods interior areas. Overwash was not a major problem from Wilma, as the mainland is located on limestone bedrock that gently slopes upward from the sea. There was some localized overwash, which mostly affected mangrove vegetation.

Beach transport consists of the erosion and deposition of sand along the shoreline. It is influenced by the wind direction and waves, and in the case of Wilma, the highest winds occurred from the east southeast, which resulted in the scouring of sand along the northern reaches of the coastline - this effect was especially evident along the Barrier island off of Cancun, and sand deposition at southerly locations along the coast. In Puerto Morelos, several small piers are now buried in sand. Besides causing the obvious damage to swimming beaches, erosion exposed foundations in some locations.

Flooding - Rainfall on the Yucatan Peninsula from Wilma ranged from 9 to 14 inches. As the soil is thin and the underlying geology consists of fractured, but only moderately porous, limestone, water drained slowly in many locations. In urban areas, consisting of large amount of impervious surfaces, natural drainage was further challenged by the higher amounts of run-off. Flooding was a major problem.

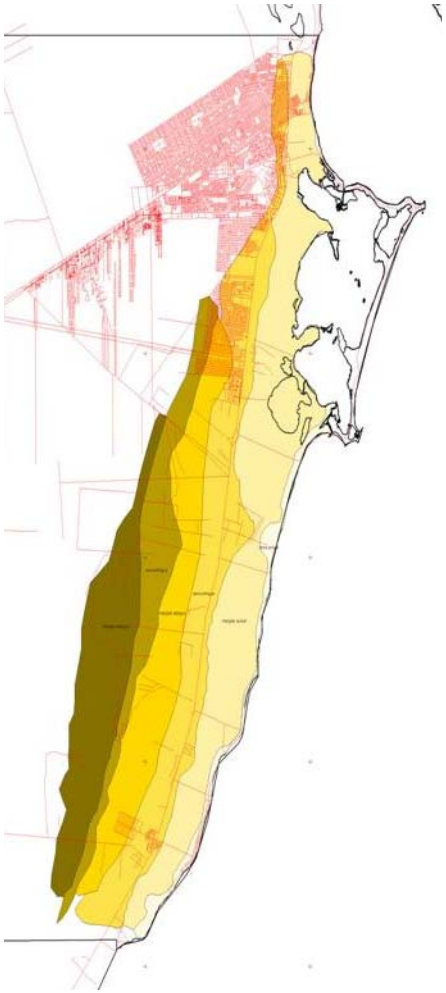
However, a major factor contributing to the extent, duration and damage resulting from flooding was the natural topography of the region. Along the existing coast line are dunes, built of sand deposited by storms. Behind the dunes lie Mangrove swamps, coastal wetlands important to the marine ecological system that extends to the offshore reefs.

"The importance of mangrove swamps has been well established. They function as nurseries for shrimp and recreational

fisheries, exporters of organic matter to adjacent coastal food chains, and enormous sources of valuable nutrients. Their physical stability helps to prevent shoreline erosion, shielding inland areas from severe damage during hurricanes and tidal waves."

While providing a buffer from surge, mangrove swamps also absorb runoff and shallow percolation from the mainland, and act as short acting retention ponds, as the outlets from the mangrove swamps is overwhelmed by the flood water.

But there are historic dunes and mangrove swamps, now fossilized, which also affect the regions response to flooding. Map 1, a new map produced as part of the UTF based on original research, displays a series of three sets of dunes is located along the coast line. Farthest to the right is today's narrow dune band and next to it in light green lies today's existing mangrove swamps. To the east of today's mangrove swamps are located two elevated ridgelines made of ancient dunes. These are shown in darker shades of yellow. Behind each of these ancient dune systems are low-lying areas, the fossilized remains of ancient mangrove swamps. These areas are shown in shades of darker green. All the fossil strandline and mangrove units were formed during Pleistocene Interglaciations when the sea level was equal to, or higher, than the modern level. The one nearest the highway (strandline and mangrove couplet) formed during the last interglacial which was centered at 125 thousand years ago. The other couplets likely formed



during earlier interglaciations but research has not determined the age from these units.

Flood water falling behind the fossil dunes is collected and held in the lower ancient mangrove areas. To drain, flood water must slowly percolate though the fossilized sand dunes, a process which can take several days or more. Therefore, the ancient mangrove areas act as a reservoir for flood waters.

Sea Level Rise -An important issue to consider in this discussion of hurricane damage is that the water level in the ocean is rising. This is not a new phenomenon, the level of the ocean has risen approximately 120 meters in the last 18,000 years, as water stored as ice in glaciers slowly melted. However, after an estimated 3000 years with little change in the oceans, a renewed rate of rise has been observed since 1900. The planning Team secured information and actual measurement data about sea level change in the region from a variety of sources, including US EPA , and published reports . However much of the actual data was collected over a period of time which makes interpretation unreliable . As a result it was thought prudent to reply on global coastal average of 3.7 mm/yr obtained by Holgate and Woodworth 2004 (GRL 31, L07305) as the best estimate for the Peninsula. If this rate continues some sources project "a sea level rise of 0.09 to 0.88 m for 1990 to 2100, with a central value of 0.48 m" . Developments along the beachfront coastal areas need to take sea level rise and its possible contribution to hurricane damage into serious consideration.

Planning Considerations to Mitigate Future Hurricane Damage

Wind - First, of all it is important to note that the concrete block and reinforced concrete construction methods universally employed in urban centers such as Cancun region are far less susceptible to wind damage than structures built with methods commonly found in the United States. Photos and buildings examined by the UTF did not display any evidence of major direct wind-induced structural failures. There appeared to be a small number of progressive failures, where the roofs failed and then some, or all, of the structure failed. Such financial loss can be avoided by including building code requirements for improved tie-downs, especially at edges . Despite the lack of structural failures, it is a good idea to require large buildings, especially those in the urban environment, to undergo wind tunnel testing both of the building and to include the building's neighborhood environment and to insist that structural engineers perform load calculations on the building envelope and rood top equipment . In rural areas, however, it was reported that traditional wood and thatched dwellings sustained serious damage.

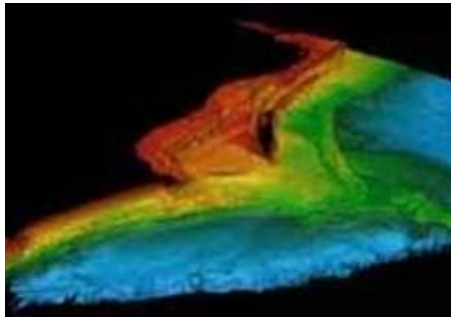
However, damage to the glass was a major problem resulting from Wilma. Engineers have extensively studied the this kind of damage and several studies confirm that small missiles, such as roofing gravel and other missiles have sufficient strength to shatter even thick hotel windows when propelled by hurricane force winds . While wind borne debris may have been a major cause of broken glass in the downtown, it appears likely that glass damage to oceanfront structures might have been the result of wind-induced changes in pressure along the outer shell of buildings, perhaps as a result of gusting. If this is to be prevented methods to shield the glass on new and existing building need to be developed and implemented. The only reliable protection is to cover windows with other

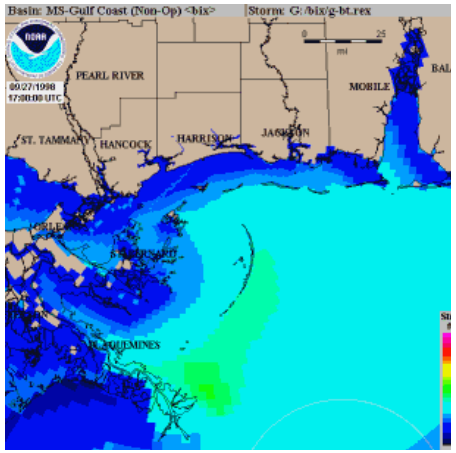
materials, such as wood sheets. Other types of wind damage from Wilma need to be collected and the newer building codes now in effect in Florida should be scrutinized for ideas to be incorporated in the local building codes. It also is important, once specific mitigation techniques have been established, to communicate these ideas to the local design professionals and builders.

Another way to reduce damage is to utilize decorate planting materials which are less susceptible to wind damage, or to producing wind borne debris and projectiles.

Waves - Surge can be modeled using programs such as SLOSH. Bathymetry along the coastline, which was completed in the mid-1990's needs to be obtained from the Mexican Navy and made available for surge simulations. Care should be taken to simulate several storms, varying in intensity and direction. Since these computer simulations have fairly large standard errors in their predictions, the many resulting areas prone to surge might be overlaid into a sort of probability surface. Areas identified with higher surge damage probabilities might be deemed less suitable for development. Existing buildings in areas prone to surge damage should be informed of the hazard, so the owners can implement mitigation efforts (such as the establishment of energy reflective seawalls).

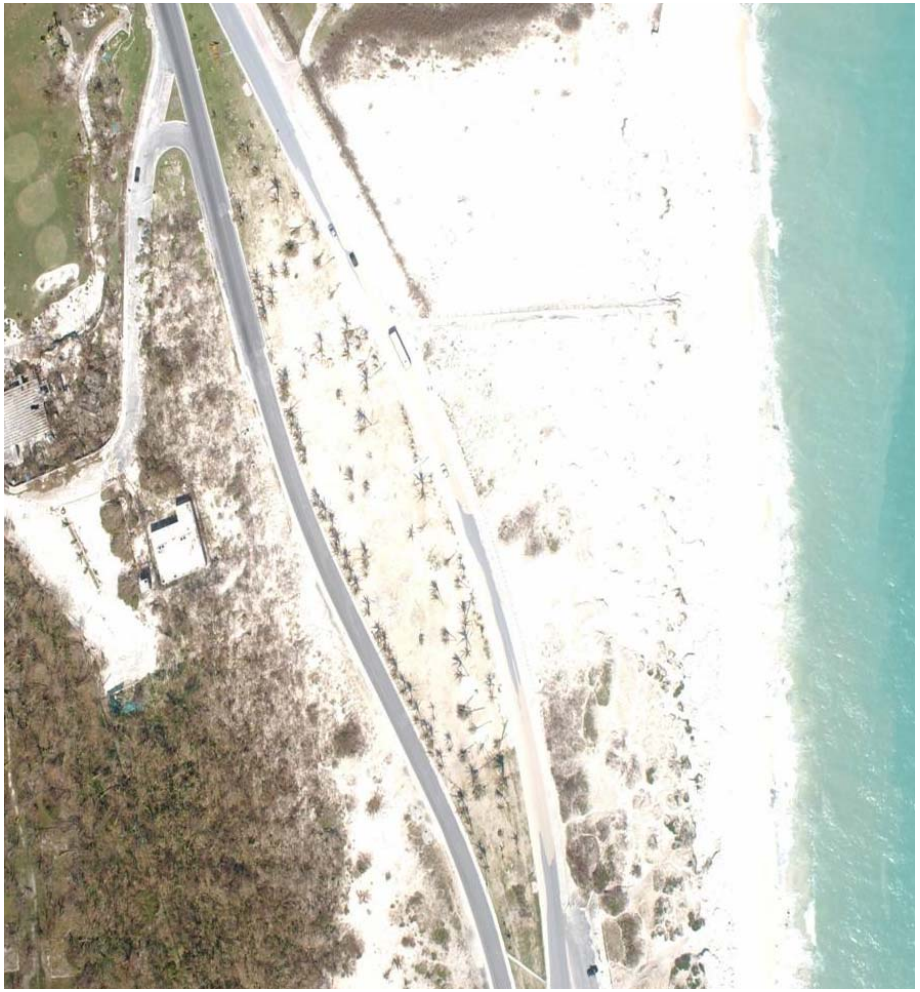
Beach transport can be mitigated in highly developed areas, such as the hotel on the barrier island, through the constructions of groins. However, the effectiveness of groins to mitigate beach transport during a hurricane is doubtful. There also is evidence that the construction of vertical seawalls exacerbates beach erosion . Beach erosion and sand transport during hurricanes can only be mitigated by implementation of set-back limits and





Beach erosion

Overwash



restoration of natural dunes and their associated vegetation. Whenever that is not possible, the construction of energy-dissipating types of sea walls can be used but set-back limits are still adviable. More detailed engineering studies should be made of this issue and possible some consideration given to removing the existing vertical seawalls if possible, and definitely prohibiting the construction of new vertical seawalls along the beach front areas of the region.

It also is recommended that the pre-Wilma and Post-Wilma aerials collected by IMPLAN during the course of the UTF be used to accurately assess and document beach transport as well as document areas where overwash occurred. Such analysis can assist to document areas more or less suitable for development, especially along the coast to the south of Cancun.

Flooding - Every effort must be made to preserve the existing natural outfalls for flood water from Mangrove swamps. Extensive construction in low-lying areas, the former locations of ancient mangrove swamps, should be avoided, as these area capture flood waters and are slow to drain. Development parallel to the coast should be focused on the dune areas and to preserve future development options the continuation of quarrying of these areas needs to be carefully considered. Similarly, areas excavated by the quarrying now represent areas prone to surge-induced flooding and any construction in these areas should recognize this fact.

CONCLUSION

It is likely that the scenario that best matches the future of Cancun results from a combination of the three scenarios presented in this report.

Therefore, many of the issues discussed on each scenario would have to be addressed and planned. Since a successful urban planning strategy in a complex urban fabric such as this requires a strong determination to improve existing conditions by creating strong relations with the context through a clear sense of location, position and orientation.

This establishes a coherent urban environment that not only unlocks private sector development possibilities but most importantly redefines the regional center structure with the creation of a coherent public place that enhances the activity of its residents and users.

The Ciudad Turismo Scenario is believed to be the most likely if the government does not support a revision of the current development approach. The Urban Task Force estimates that Cancun will recover from Wilma and follow a continued moderate growth pattern with this scenario.

The Ciudad de Communidades would have an improved growth pattern with a more distributed socio-economic base. And the Ciudad Central scenario would have the highest potential by capturing regional and international commerce complementary with an expanding tourism industry.

Population projections for 2030 based on these scenarios range from 1,500,000 to 2,000,000 but the density would vary considerably, with the "mass tourism" model showing the highest density and the "ciudad de comunidades" model the lowest.

In the end, Implan's challenge will be to create a master plan for the municipality that considers the same factors forming the basis for the UTF program: promote economic opportunities, social equity and environmental quality.

Cancun and the Mexican Riviera is an extraordinary place that has the potential to be one of the most memorable tourism experiences; a vital Caribbean trade centre; and an environmental heritage for the people of the Yucatan, Mexico and the world.

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