Transport system environmental assessment of an urban agglomeration integrated in a coastal wetland: Bay of Cadiz

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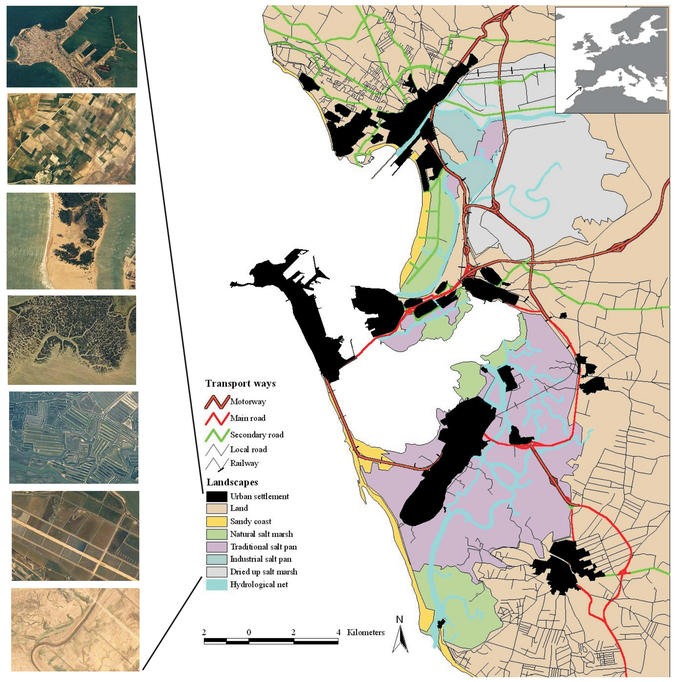
Abstract

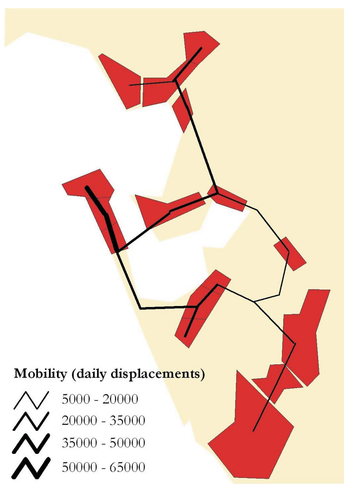
This report identifies and evaluates the environmental and social impacts of the transport sys-tem on the Bay of Cádiz, such a littoral space characterized by the coexistence of urban set-tlements and natural environments. Space occupation by transport ways has been utilized as an indicator to evaluate the system evolution and its territorial impacts, according to different strategies of mobility depending on the share of transportation modes. The results show that transport infrastructures represent the main responsible factor of the impact caused by the transport system over the Bay of Cádiz, affecting key elements of the littoral system such as hydrodynamics and sediment dynamics, and the most sensitive environments. Therefore the transport system must be considered as a fundamental factor in the conservation policies in the Bay of Cadiz. On the other hand, the Bay of Cádiz holds a great potentiality to reduce the cur-rent pressure of the transport system over the littoral environment, by means of an alternative transport model based on minimizing the infrastructure requirements.

Study area



The Bay of Cadiz constitutes an area of exceptional value characterised by the coexistence of urban and natural environments in the last 3,000 years. It comprises an area of sea-land space on which a polinuclear urban system is integrated forming a complex and diverse area. The sea-land landscape of the Bay and its dynamics are characterized by a horizontal component bringing about much frailty to the space. This horizontal transport connecting land and sea is responsible for the maintenance of the salt marsh

Mobility structure and transport system



Metropolitan relationships in the Bay of Cadiz, although incipient, are nonetheless under a strong development. It is a system of complete cities with services adequate for their sizes, far from the classic periphery-centre model of metropolitan cities. The capital, Cadiz is, relatively, an important centre of leisure, cultural and official activities. The independence of the cities allows the number of daily displacements to be low, both on an urban scale and on foot. However new metropolitan land uses and relationships, mainly developed throughout the last decades and promoted by the increase of motoring, have generated the rise of metropolitan mobility. The intensity of fluxes in the transport infrastructure main net presents a decentralised structure for mobility.

In modal share of transport, private vehicles represent an 80% of motorized movement. Mass transport shows a decrease in usage due to its insufficient development. Additionally, transport planning and policies during the last decade have been based almost exclusively on building infrastructures for private vehicles and their access to the capital from the rest of the cities.

Impact inventory

Two impact groups, caused by transport infrastructures and by mobility, have been identified in 4 types of environments (urban settlements, intertidal zones, sandy coasts and continental land) in which the study area has been divided.

Intertidal zones

* Land take, space fragmentation and strangulation of tidal creeks (Pictures 1,2,3,4,5,6,7,8,9 and 11)
* Modification of the water and sediment dynamics
* Barrier effect for aquatic and intertidal fauna
* Destruction of vegetation (10)
* Introduction of aloctonous species, encouraged by topography and soil type changes
* Landscape impact (contrast between the dendrite-like network of tidal creeks and the lineal network of transport ways) (12)
* Acoustic pollution affecting wildlife
* Water and soil pollution due to dry and humid deposition of atmospheric pollutants.

Sandy coasts

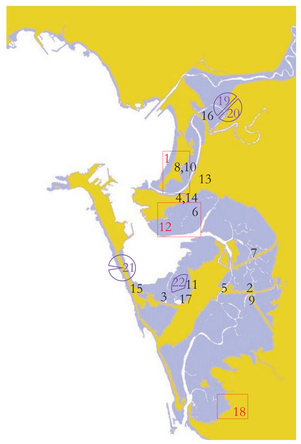
* Transport infrastructures mainly occupy dune systems (15)
* Beach erosion due to the loss of sand reserves
* Interruption of aeolian sediment dynamics and of sediment transference processes between the beach and the lagoon or salt marsh
*.Destruction of very valuable habitats and barrier effect for their fauna
* Landscape impact (rupture of the transition between sandy spit and lagoon or salt marshes)

Land

* Expansion of urban settlements and increase of road networks (intense fragmentation, important loss of natural assets) (13, 16 and 18)
* Changes on superficial hydrology
* Barrier effect for people that provokes access problems in some places (17)
* Motorized accessibility to protected areas (14)

Urban areas

* Intesification of attmospheric and acoustic pollution
* High density of the urban network
* Social impacts are also intensified in urban areas (incommunication of the cities, spatial segregation, social discrimination)



Space occupation by transport infrastructure

Occupied surface according to type of transport way

Type of transport way	Length (km)	Average width (m)	Occupied surface (km^2)	% total ways
Motorways	76.5	50	3.8	33.54
Main road	48.1	25	1.2	10.54
Secondary road	78.2	15	1.2	10.28
Local road	535.9	8	4.3	37.57
Railway	46.1	20	0.9	8.07
Main network	100.6		3.25	28.51
Total	784.8		11.4	100

The main transport network, which supports the metropolitan mobility, represents 28.5 % of the total surface assigned to roads. Among the types of transport ways, motorways stand out occupying one third of total space assigned to non-urban roads, being the roads with the greatest environmental and social impact (due to the high fragmentation they produce). Furthermore, the 31.5 % of the total distance covered by motorways is built over the most sensitive environments of the littoral space (i.e. salt marshes and sandy spits).

Space occupation according to type of environment

Type of environment	Transport way surface (km^2)	Occupation (%)
Land	8.33	4.18
Salt marsh	2.01	1.90
Sandy coast	0.48	5.96
Total non-urban roads	11.4	3.22
Urban settlements	15.4	40.00
Total	26.8	7.56

Among the types of environments, sandy coasts represent the highest road occupation, mainly due to their density over the Cadiz isthmus. Land and salt marsh environments present a great difference in road occupation. Continental land presents a high road density, yet with a heterogeneous spatial distribution. Hence the highest road density is found in urban spread zones. Few transport ways cross the active or dried up intertidal zones, although these are of great size (motorways, main roads…). However, the affected extension of salt marshes is wider than the surface occupied by roads. The strangulation of tidal creeks in their intersections with transport network produces changes in the hydrodynamic regime, affecting the creeks' total flooding surface.

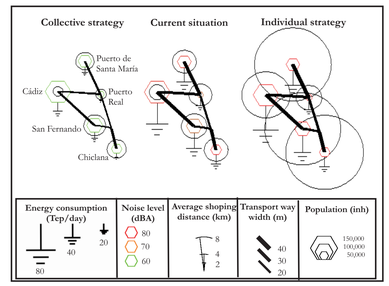
Mobility strategies and future scenarios

Environmental impact indicators of the transport system in the current and projected situations

Mass transport share (%)		Energy consumption (Tep/day)	Noise level (dBA)	Average shopping distance (km)	Space occupation (km2)
20	Current situation	196.7	72	2.27	3.25
100	Individual Strategy	216.8	75	5.74	3.42
0	Collective Strategy	80.7	58	1.67	2.22
	Variation margin (%)	*10.2 / -59.0*	*4.2 / -19.4*	*152.9 / -26.4*	*5.1 / -31.7*

The space occupied by the main transport network has been evaluated in the current situation, and for two different mobility strategies depending on the mass transport share and the metropolization evolution. These projections show the variation margin of the transport system's pressure over the littoral. The Individual Strategy projection shows that the current situation is close to the most unfavourable, since the suppression of the metropolitan mass transport would only require extending the roads in a 5 % to satisfy the current mobility. The current projects to extend the roads in the Bay, such as some road duplications or the construction of a new bridge over the Bay, might mean the completion of that mobility scenario.

On the other hand, the Collective Strategy projection shows a greater profit due to the liberation of space with the increase of mass transport participation. In this strategy, the decrease of transport infrastructure pressure over the littoral exceeds a 30 % in all inter-city relations. These values show the potential of disoccupation and restoration of environmentally valuable zones, affected by transport infrastructures.



The energy consumption shows the inefficient character of the current strategy of mobility and the great potential of transport system, which would contribute, for example, to reaching the international agreements for the reduction of greenhouse gases emissions.

The average distance of shopping displacements is an indicator of the metropolization degree of the Bay's city systems. The values of this indicator show a high degree of functional independence among the urban settlements of the Bay for the present situation. On the contrary, this indicator shows an important increase of metropolitan relationships consequent to the increase of car use in the shopping displacements. This increase would reflect on the demand of transport infrastructure, which would raise the projected value of space occupation in the Individual Strategy.

Conclusions

- The impact caused by the transport system over the littoral environment on the Bay of Cadiz is mainly due to the transport infrastructures and may be considered very high. These infrastruc-tures affect key elements of the littoral system, such as hydrodynamics and sediment dynamics. Therefore the transport system must be consid-ered as a fundamental factor in the conservation policies in the Bay of Cadiz.
- The transport infrastructures built in the Bay of Cadiz the last decades have provoked deep changes both in the dynamics of the cities and in the Bay's landscape.
- Both environmental and social components of the system are similarly affected by negative im-pacts of transport and both are benefited from the reduction of those effects. Therefore, there is no interest conflict between conservation and population requirements. On the contrary, environmental and social vectors go in the same direction.
- Space occupation and fragmentation are the main impacts caused by transport infrastructure. The most sensitive areas, salt marshes and beaches, also support a greater pressure from the transport system, because of the high occupation index in some of them and because of the pres-ence of infrastructures with the greatest impacts on others.
- Due to the space frailty and the shortage of use-ful soil in the Bay of Cadiz, space occupation presents a high environmental and social cost. This justifies the priority of measures focused on minimizing soil occupation, such as those to re-duce the space assigned to transport infrastruc-tures.
- The Bay of Cadiz presents a great potential to reduce the current pressure of the transport sys-tems over the littoral environment, given the high environmental profitability due to the increase of mass transport participation in the daily mobility, and given the high potential to develop a transport system minimizing the infrastructure require-ments, based on the train, maritime transport and non-motorized transport modes.
- However, the current and potential metropoli-tan processes of the Bay's city systems may in-volve a considerable increase in the demand of metropolitan transport infrastructure, and, conse-quently, a pressure increase over the natural space of the Bay.