Strategic planning for equitable territory development: the case of sustainable water and wastewater infrastructure in Northeast Portugal

Introduction

Douro sub-region has been, for the past decades, the focus of several projects and territorial development programmes that shared common purposes. Specifically, these include World Bank funding in the beginning of the 1980s and additional support from the European Union in the 1990s. Based on the mobilization of the local growth potential and resources, these strategic plans and programmes aimed at social and economical development, job creation and improvements to the quality of life of the population, thus taking a rather exemplary character regarding the nature and the content of regional development policies implemented in Portugal for the same period. Consequently, several funds were channelled to the region along with renewed tools and intervention models focused on addressing development objectives and strategies, taking advantage of more than eleven programmes financed by the European Union. As a result, a new inter-sectoral approach has progressively emerged from strategies centred in upgrading agricultural production and in the improvement of the quality of life of the rural populations. This approach has been complemented with investments in infrastructure and agricultural interventions, ever since the pioneer Programme by the World Bank. The goals have been to streamline the undertaking of initiative capacity and management, the attracting and holding of qualified human resources and the promotion of tourism as well as historic, cultural and natural heritage. Simultaneously, several incentive systems were made available to the region's private agents and investors, which carried special benefits in sectors like vineyard farming and wine-making, tourism, food industry, services and local commerce.
The relative improvement of the quality of life of the populations in terms of the reinforcement and extension of water supply infrastructure coverage, social equipment network and partial modernization of the economical and social fabric are visible results and evidence of the positive impact brought by the incentives and associated investments. In fact, agriculture and tourism are the dominant economic activities, where the Douro sub-region is second only to Porto (Lourenço, 2004) in the context of the Northern region of Portugal. Notwithstanding, according to some specific economic indicators, the overall contribution to the development of this region is declining or at the very least, fails to meet expectations given the initial magnitude of policy incentives.
This paper addresses the evolution of the sustainability concept and discusses its application to infrastructure development, one of the many dimensions of urban development.

The evolution of the concept of sustainability

The concept of sustainability was first introduced in the World Commission on Environment and Development (WCED) Our Common Future report (later referred to as the Brundtland Report) in 1987. Sustainable development was defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987) and moreover, a worldwide purpose and commitment to ensure that the generations to come enjoy levels of affluence and development comparable to those of nowadays. Achieving sustainable development and ensuring environmental sustainability are key goals for the international community, as a means to ensure human well-being. This requires that the established interrelationships between population, resources, the environment and progress be fully recognized and appropriately managed. Sustainability can be regarded as the establishing of balanced and dynamic trade-off relationships between all of the intervening components and/or parts of a system, for the duration of its life-cycle (Figure 1).

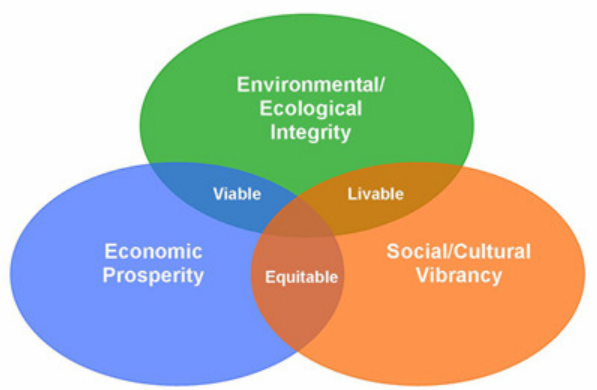

Figure 1 - The sustainable development model (Dubuque, 2008)

Social and environmental interaction leads to a liveable development, rendered viable by establishing the appropriate cooperation between environmental and economic elements. Finally, an equitable society is one where social and economic needs are balanced.
This vision for sustainability evolved later to a four pillar instead of the three initial ones. To the social, economic and environmental dimensions, culture was also added (Bolsius *et al.*, 2000) as an independent vector of its own (Figure 2).
The implementation of measures for sustainable social and environmental conditions results in economic sustainability as well. Therefore, planning, management and policy-making should be conducted in such a way as to ensure healthy economic growth, citizen satisfaction and adequate maintenance, development and redevelopment of infrastructure (Daniell *et al.*, 2005). But all this research on sustainability has still to overcome the real problems of measuring and integrating these quite distinct dimensions, some of which cannot be directly quantified.

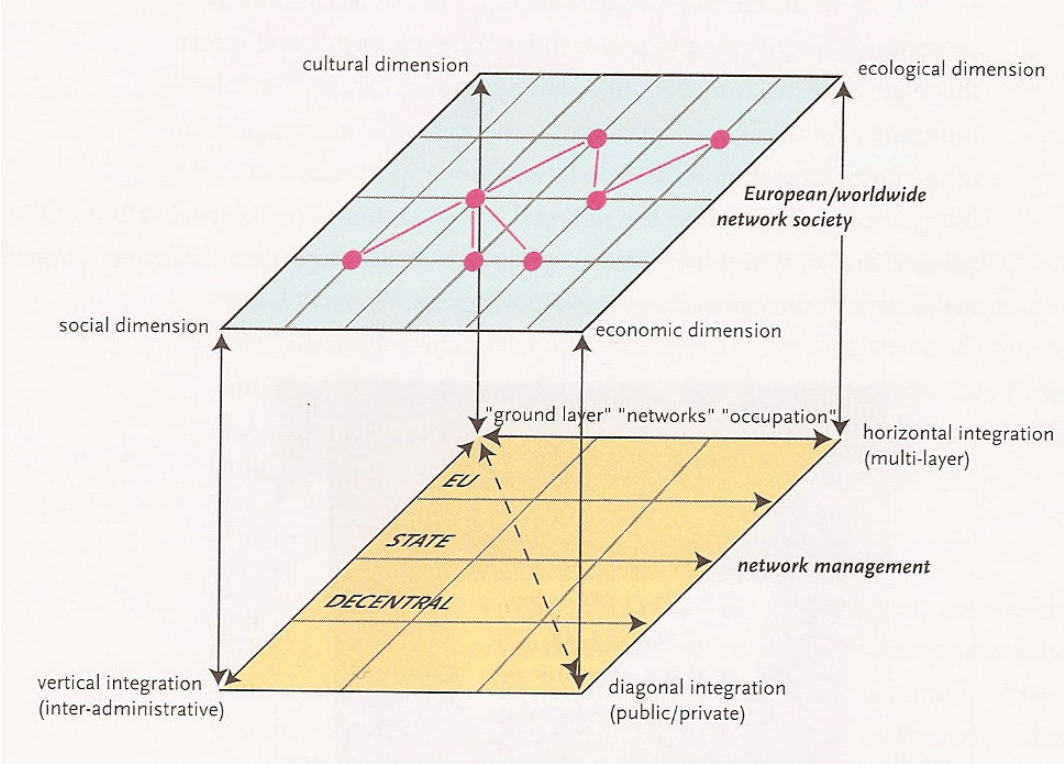

Figure 2 - The sustainable development model (Bolsius *et al.*, 2000)

This multi-scalar approach from local to supra-national level encompasses the former simplified version and focuses on networks, management optimisation and the role of private entrepreneurship. But the implementation of sustainable development still remains a problem

as trends regarding a variety of contexts such as climate change, energy use, public health, poverty, social and demographic issues, management of natural resources and biodiversity, land use and transportation continue to worsen. It is well known that after the first European Union Sustainable Development Strategy (EU SDS, 2001), there was the need to revise its strategy and a new EU Sustainable Development Strategy was released in June 2006. This renewed EU SDS focuses on four sets of key objectives, namely (1) environmental protection; (2) social equity and cohesion; (3) economic prosperity, and (4) meeting of international responsibilities. It calls for "cross cutting policies contributing to the knowledge society", under which "research into sustainable development must include short-term decision support projects and long-term visionary concepts and has to tackle problems of a global and regional nature". Additionally, research is to be promoted and carried out via inter- and transdisciplinary approaches that ideally combine social and natural sciences and thus bridge the gap between science, policy-making and implementation. The EU SDS also calls for further development of smart growth-related technologies and addresses the strong need for the intensification of research in the interplay between social, economic and ecological systems, methodologies and instruments for risk analysis and back- and forecasting prevention systems (EU, 2006).

The particular case of sustainable urban policies has been the subject of the 2007 Leipzig Charter on Sustainable European Cities (UDTC, 2007a and 2007b). Amongst its many recommendations, the coordination between local and city-regional levels and the involvement of citizens and other stakeholders are seen as essential implementation-oriented tools towards the drawing up of urban development programmes. Furthermore, these programmes should be supported by assessments of strengths and weaknesses of each city and/or neighbourhood, aiming towards an early coordination of housing, economic, infrastructure and services. The modernization of technical infrastructure networks, particularly those for water supply and wastewater collection and treatment is urged along with early-stage improvements adapted to changing requirements to meet future needs at a high quality level (UDTC, 2007b).

The Portuguese National Strategy for Sustainable Development (ENDS 2015) was approved in 2007 along with its corresponding Implementation Plan (PIENDS). The strategy focuses on steering the Country's development processes according to sustainability guidelines, integrated with existing and/or soon to be available instruments, plans and programmes, including those that concern European funding up until 2013, while vying for the participation of citizens and a variety of economic and social agents. Seven fundamental purposes are established, supported by the three traditional pillar-concepts of sustainable development: social cohesion, environmental protection and valorisation and economic development. Consequently, the ENDS 2015 is complemented by a series of other strategies, programmes and plans, including the Portuguese Programme of the Policies for Land-Use Planning (PNPOT), also approved in 2007. This particular programme establishes a series of objectives regarding strategic options encompassing all dimensions of sustainable development, including that of territorial equity in terms of the endowment of infrastructures, namely for water supply and wastewater collection and treatment, and their management from a social co-responsibility standpoint.

Specifically, the PNPOT stipulates the implementation of the Strategic Plan for Water Supply and Wastewater Collection and Treatment (PEAASAR 2007-2013), so that water supply and urban wastewater collection and treatment goals are fulfilled for the majority of the population, at high quality levels, reasonable prices and by way of necessary funding and investment. The PEAASAR 2007–2013 was also approved in 2007, following in the steps of its predecessor plan, the PEAASAR 2000–2006, which focused on the structuring of the water supply and the urban wastewater collection and treatment sectors from a social, environmental and economic sustainability standpoint. Having successfully accomplished most of the previous objectives, the 2007—2013 seeks to minimise systems' inefficiency from a cost rationale perspective, while establishing financing models and guidelines for proficient rate and regulation policies (MAOTDR, 2006). Three main strategic objectives are defined, namely (1) universal access to, continuity and quality of the services rendered; (2)

sustainability of the water and wastewater sector, and (3) environmental protection. The completion of these goals is intrinsically linked to operational objectives, thus defined:
a) To provide approximately 95% of the total Country's population with public systems of water supply;
b) To provide approximately 90% of the total Country's population with public systems of urban wastewater collection and treatment, covering at least 70% of the population for integrated systems;
c) To guarantee the integral recuperation of service costs;
d) To promote the private national and local entrepreneurship; and
e) To fulfil the objectives from national and European regulations for environmental and public health protection.

Sustainability status of selected municipalities in Northeastern Portugal

Selected municipalities in Northeastern Portugal were ranked according to the state of their water and wastewater infrastructure. A series of sustainability indicators were used to establish a multicriteria analysis approach to determine the level of sustainability exhibited by eight municipalities in Northeastern Portugal. Alijó, Mesão Frio, Peso da Régua, Sabrosa, Santa Marta de Penaguião and Vila Real from Douro, Murça and Vila Pouca de Aguiar from Alto Trás-os-Montes, all were selected because of their transitional location between the more developed coastal areas and the interior Northeast of the Country (Figure 3).

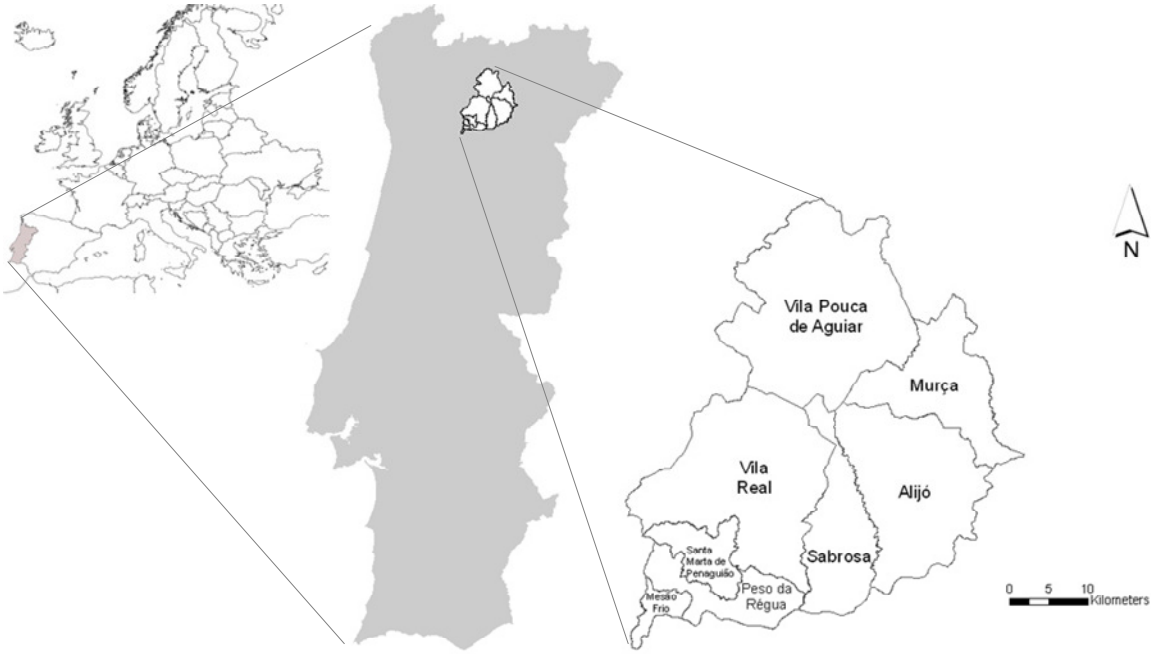

Figure 3 – Case study area in relation to Europe and Portugal

The study area is an interior region of the country that has long suffered with population decline in favour of the more developed coastal areas, a migration dynamics that is driven by a number of different factors. Cities and towns within coastal areas, particularly the metropolitan areas of Porto and Lisbon, offer more job opportunities and consequently, a better chance of improved life conditions. The uneven distribution of people across the coastal and interior areas of the country has carried standing effects on urban growth and development. Having struggled with this phenomenon over the last five centuries, after the Discoveries, Portugal has nowadays called on extensive strategic programmes aimed at protecting and assisting the more deprived interior, offering the possibility of a more equitable territorial model for development and well-being. The strategy focuses on steering the

country's development processes according to sustainability guidelines, while vying for the participation of citizens and a variety of economic and social agents.
A snapshot of the area under study is graphically portrayed in the following illustrations. According to the latest census update (INE, 2008), the region accounted for approximately 4.1% of the total population in the Country. This is considered a sparsely populated area, yielding a mere 43 inhabitants per km^2, which is a value well below the national average of 115 inhabitants per km^2. Historically, population numbers have been gradually declining for the entire Northeastern region (INE, 2008). This population decline is related to several local factors, particularly migration in search of better employment opportunities, towards the more developed coastal areas (the Portuguese Northwest has actually recorded an increase in total population numbers) or even abroad (Figure 4).

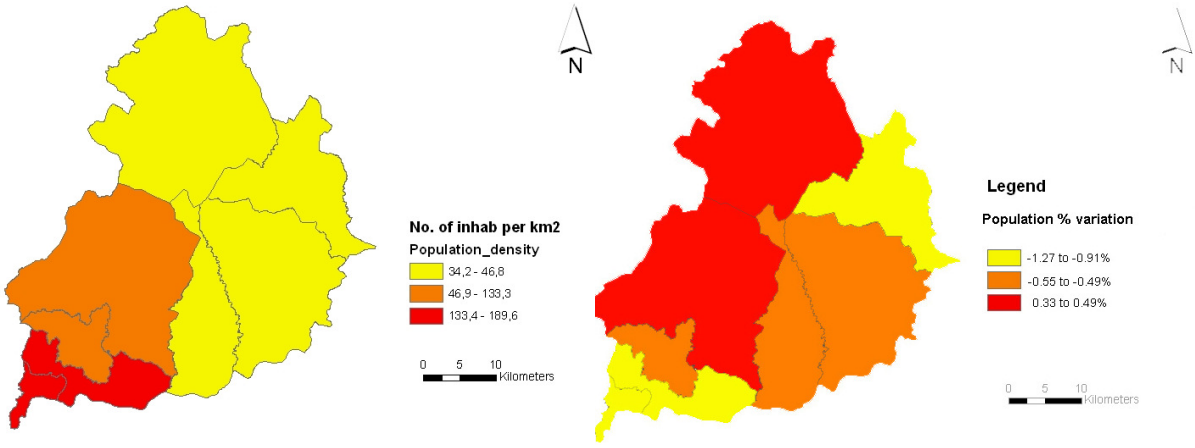

Figure 4 - Population density and percent variation in the study area

Local employment and unemployment trends are directly related to the effects of globalisation, as observed in recent years across the region (CCDRN, 2007). Unemployment rates in 2006 for the region were fairly high, at 4.49% on average, when the national average was approximately 4.03% (IEFP, 2008; INE, 2008). Nevertheless, when compared against European figures, those are favourable rates and well on their way towards meeting the European Strategy for Employment recommendation of global employment rates of 70% by the year 2010 (CCDRN, 2007). See Figure 5.

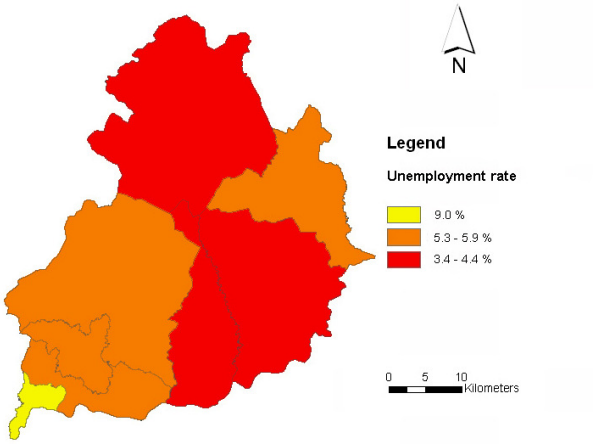

Figure 5 – Unemployment rates in the study area

Water and wastewater systems benefitted from financial support by the World Bank in the 1980s. Additional funding was provided upon Portugal's admission into the then-designated European Economic Community (EEC) in 1986. These incentives and a continued concern with expanding, upgrading and renovating the existing networks have resulted in significant improvements to the infrastructure that, along with urban densification, has placed the sub-

regions at or above the national average for service coverage. By 2005, service coverage in Northeastern Portugal by water systems exceeded the minimum 95% requirement stipulated in PEASAAR 2007-2013. In terms of wastewater service, coverage topped the national average of 76%. However, the 90% requirement of population coverage was not met (MAOTDR, 2006) and in Sabrosa the attendance level is still very low (Figure 6).

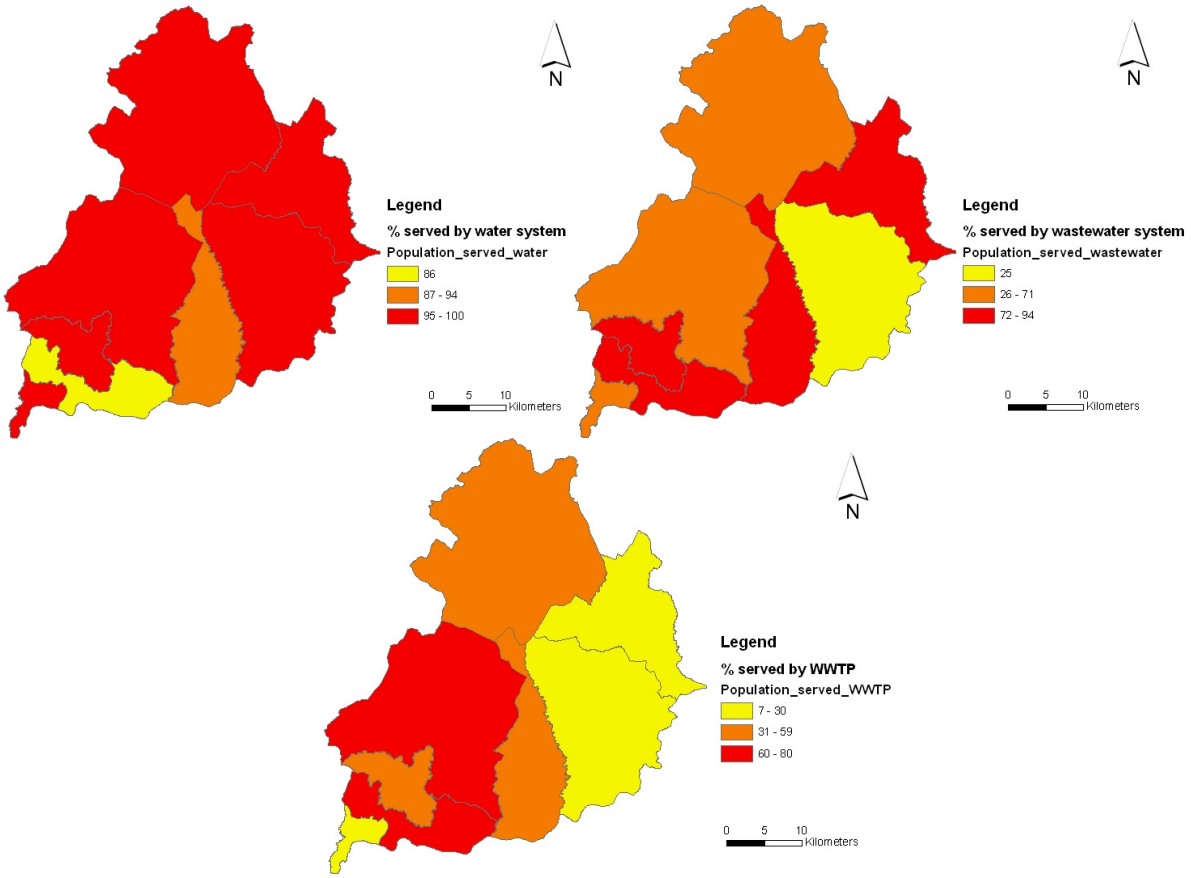

Figure 6: Water and wastewater service coverage in the study area

Area background

The heterogeneous topography of the region is responsible for the rather severe variations in climate conditions across the region and throughout the year. Spatial climate variations can be quite extreme (severe droughts and frequent flooding) and microclimate areas can be identified, attending to the differences in sun exposure and wind direction derived by the distinct morphological features of the terrain.

Exhibiting a large diversity of morphological, ecological and climate conditions, the region displays great natural and cultural heritage variety. The region includes a natural heritage that is intimately linked to the agro-forestry uses of the land and few regions of the Country can claim such breadth and relevance of natural heritage, with a humanized, evolving landscape consequence of the work by successive generations and that have secured Douro Valley the title of World Heritage by UNESCO in 2001.

Three main trends have been observed for rural development: (1) the complementarity and interchangeability between agricultural, forestry and tourism uses; (2) the global regression of the agro-forestry uses, and (3) the expansion of barren land. In regional terms though not in a homogeneous manner, agricultural uses have decreased while forested and barren land areas have increased.

Primary activities are amongst the main contributors to the national agricultural sector regarding the production of high quality products, including wine, olive oil, dried fruits and fresh fruits. This is an essentially rural area, where agricultural activities, more than only a

means for supplying food demands, are also important agents of geographical occupation, affecting the dynamics of other sectoral activities such as tourism, handcrafts, gastronomy and agro-related industry. Landscape, agro-ecosystems and environmental features are also significantly impacted by agriculture. However and since the 1990s, agriculture has steadily decreased despite an increase in land productivity, accompanied by an overall reduction of arable land and increase in forestry and non-cultivated uses. The simultaneous increase in animal-farming and dairy productivity has not been able to offset the decay of the primary sector. Factors such as decline of human occupation and farmer aging have been pointed out as possible causes for the phenomenon. These may be factors that prevent further investment, potentially jeopardising productive systems themselves (Melo and Lima, 2000). Exceptionally, vineyard farming has seen an increase in Douro. In fact, between 1990 and 2000, there was an increase in the areas devoted to urban uses, vineyards, eucalyptus forests and areas lost to forest fires, particularly around the urban cluster of Alto Trás-os-Montes (Lourenço et al., 2008).

The existing enduring diversity of tourism resources allows tourism activities to be some of the main contributors to the region's wealth. The supply of transportation to areas of low population density is increasingly disappearing outside of the main urban areas, hindering mobility and circulation of people and goods. Areas affected by lack of adequate mobility solutions exhibit a reduced ability for competing with other areas where the transportation infrastructure is not as lacking. These are disparities not only of a territorial but also of a seasonal nature. Throughout the year, there are significant variations in mobility patterns that particularly affect rural and urban fringe areas. They result in discontinuity and inconsistency in mobility behaviour because the affected areas are not adequately supplied with sufficient and specific transportation alternatives (CCDRN, 2007).

The main accessibility network has been the target of significant investment since the start of the Community Support Framework I (QCA, *Quadro Comunitário de Apoio*). This is an area where accessibilities have been improved particularly over the past 1990-2000 decade, followed by urban development that intensified the disproportion between interior and the significantly more developed coastal areas. It is important to note that this west-east disparity is not due to a deficiency of plans and/or programmes when in fact there are many types of development plans providing extensive coverage for the region. Yet, the Northeastern Portugal continues to struggle with a chronic lack of critical mass that is fundamental to generate desired levels of urban growth and development that could potentially enable competitiveness with the far more successful coastal areas.

According to CCDRN (2007), it is expected that after the current National Road Plan (PRN, *Plano Rodoviário Nacional*) is concluded, over 80% of the municipality seats in Norte will be less than 30 minutes away from a Main Itinerary (IP, *Itinerário Principal*). If this is accomplished, there will be new functional connections, interdependencies and centralities in terms of traffic, which will lead to the redefinition of network hierarchy, a favourable factor in terms of territorial competitiveness and cohesion (CCDRN, 2007).

Analytical methodology

A series of indicators was defined for applying a multicriteria approach in order to assess the level of urban water and wastewater system sustainability in each one of the selected municipalities. The final selection was based on examples and discussions provided mainly by Hellström et al. (2000), Sahely et al. (2005) and Kashem and Hafiz (2006). Some parameters are directly related to the topic of water and wastewater infrastructure while others were included to provide some measure of the sustainable character of each municipality. These surrogates include, for instance, total per capita urban solid waste collected and recycled and per capita electrical energy consumption.

The indicators were organized into three groups following the structure of the sustainability model – social, environmental and economic – and organized in analytical tiers, based on the Analytical Hierarchy Process (AHP). Each indicator was assigned a specific weight ($\square_i$) using

the pairwise comparison technique presented by Saaty and Vargas (1991). For a general presentation of indicators and weights applied, see Appendix I.
Raw data was obtained mainly from The Portuguese Institute for Statistics (INE, *Instituto Nacional de Estatística*) for year 2005. Data were normalized using the Score Range (SR) method, as presented in Malczewski (1999) and after defining, for each one, if an increase in each corresponding value would be considered beneficial or detrimental in terms of the municipality's sustainability. After processing, normalized data were processed using the Weighted Linear Combination technique (Malczewski, 1999). The target municipalities were ranked according to the relative score distribution, taking into account that higher scores mean greater potential for sustainability. The results are illustrated in Figure 7.

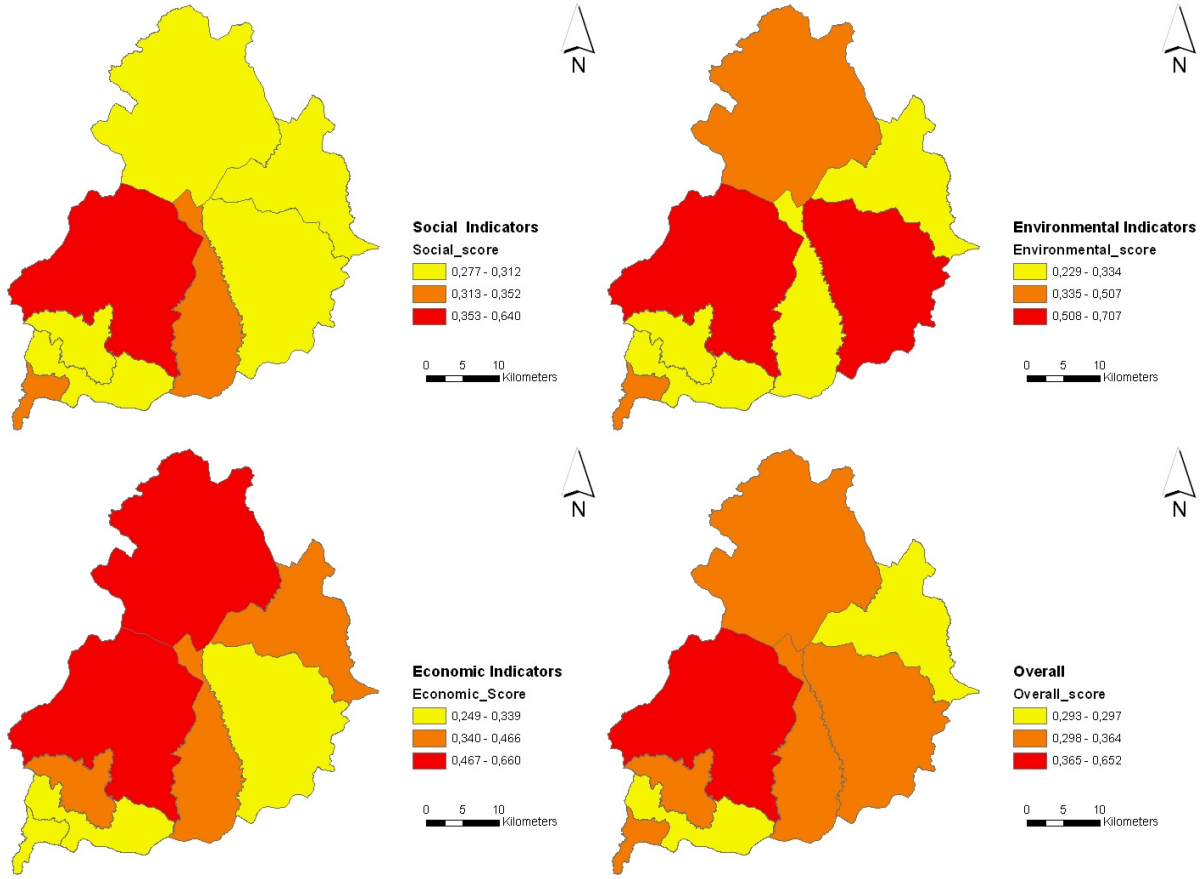

Figure 7 – Overall and partial scores

Considering the list of evaluation parameters, Vila Real was the most sustainable municipality in 2005 from amongst the target group. It consistently outranked its counterparts, obtaining the leading position in the overall ranking.
Vila Real is the most developed of the considered municipalities, exhibiting an average yearly population growth of 0.56% up until 2004, when a declining trend began at a rate of 0.07%, thus resulting in a net growth rate of 0.49% for the 2000-2006 period. Of the selected municipalities, Vila Real is the only one that displays population growth dynamics similar to the ones observed at a regional and even national level. With regards to the aging ratio distribution, most of the municipalities are above the national average of 111.7. Data show that all but Peso da Régua and Vila Real are below the national average, a fact tat mirrors the previous trend observed for the aging ratio parameter. An interesting fact is the occurrence of younger populations in the same municipalities identified before as having better accessibilities and higher urban population rates. Non-surprisingly, Vila Real is the best served municipality in terms of transportation infrastructure.
Water and wastewater service coverage was not equally available to all in 2005. According to data from the INE (2008), Peso da Régua and Sabrosa did not meet the regulated

standard for water service coverage of 95% (MAOTDR, 2006). Also, Sabrosa was the only municipality meeting the required 90% coverage for wastewater systems. In terms of wastewater treatment facilities, the regulations are not as explicit. However, minimum service coverage of 70% is required for each integrated system. Assuming the same standard applies, only Peso da Régua was able to meet the requirement.

In instances where water consumption surpassed treatment, population got their treated water from sources external to the municipality. That appears to be the case for Murça and Sabrosa. In fact, by 2005, none of these municipalities included conventional water treatment plants (WTP) or chlorination facilities and resorted to water distribution from neighbouring facilities. That was also the case for Peso da Régua and Santa Marta de Penaguião, which is served by the WTP from Vila Real. The latter is planned to serve part of the Mesão Frio and Peso da Régua municipalities in the future (INSAAR, 2005; ATMAD, 2008). As of 2005, there were six conventional WTP within the cluster of target municipalities. These facilities were complemented by seven chlorination points located throughout the distribution systems.

Wastewater collection, treatment and discharge was guaranteed by a system that included a total of 23 wastewater treatment plants (WWTP) and 126 urban collective septic tanks (CST). According to data from the INSAAR (2005), CST not only were the primary destination for wastewater treatment, they also accounted for the majority of the treated volume. Vila Real is the sole exception, where all of the wastewater is directed to and treated at conventional WWTP. Also, Vila Real is currently under a contract-programme for wastewaters, which is an instrument of technical and financial support granted to municipalities and municipality groups through the coordination of the National Water Institute (INAG, *Instituto da Água*) and Regional Coordination and Development Commission (CCDR, *Comissão de Coordenação e Desenvolvimento Regional*). These types of programmes are aimed at supporting studies, projects and work designed to meet the needs of the municipality in terms of new or existing wastewater treatment systems.

Generally, WWTP can provide a wider range of treatment levels – usually primary and secondary, and tertiary as well, though not as frequently - and better final quality. Although not necessarily comparable to WWTP in terms of treatment levels - primary level only – septic tanks offer the possibility of some treatment in locations where there are no WWTP or access to one is unfeasible. In these situations, CST simple design and operation are often the best and/or only solution available, short of having none whatsoever. The target urban areas tend to be scattered and thus, they are difficult to reach by comprehensive networks of water and wastewater infrastructure. The dispersed nature of the urban clusters in combination with the complexities of the terrain renders this area a difficult target for systems that are more inclusive.

In Sabrosa, Santa Marta de Penaguião and Vila Pouca de Aguiar, treated wastewater volumes did not match produced/collected volumes, implying that a portion of the total wastewater was not receiving the necessary and adequate treatment. The target area included 173 discharge points and of these, seven concerned untreated wastewater or direct discharges onto the receiving medium, were it a waterway or land. Approximately 4.1% of the total discharges accounted for untreated wastewater. While these are much less significant they can, nonetheless pose serious health hazards.

Total municipal expenditures and revenues are rather evenly matched, except for Murça and to some extent, Mesão Frio, showing a clear albeit not too significant dominance of expenditures over revenues. As for wastewater management, all except for Mesão Frio and Peso da Régua exhibit more per capita expenditure than revenue. Of those, account imbalances range from differences of 22% (Vila Pouca de Aguiar) to 81% (Santa Marta de Penaguião) in favouring expenditures over revenues. In terms of budgets for other environmental protection activities, Murça stands out as the only municipality exhibiting more revenues than expenditure in an excess of approximately 40%. The remaining municipalities fare rather worse, with expenditures surpassing revenues from 74% (Vila Pouca de Aguiar) to 93% (Alijó).

Conclusions

The region's mountainous morphology and climate features define the type of land uses and human occupation of the territory and limit the distribution of transportation and water and wastewater system infrastructure. Not unlike other municipalities in Northeastern Portugal, land uses for the target area are essentially related to agricultural and forestry uses, consequence of an overall decrease of natural areas brought by the increase in low density urban uses and mixed agriculture occupation. However and despite their influence, urban uses continue to have little expression in the study area. Additionally, population clusters are not limited to areas indicated as urban uses. Their small dimension and scattered nature carries some significant consequences in terms of service by infrastructure networks, namely transportation and water and wastewater systems. Since Vila Real comprises the largest of the urban areas in the target municipalities, this scattering of population does not represent a major problem for this municipality.

Harsh natural factors combined with observed population dynamics represent major hindrances to the implementation of improved levels of service, though these are not felt homogeneously throughout the study area. Nevertheless, a series of strategic plans and programmes have been released and are now in the initial stages of implementation, suggesting the continued improvement of the region.

Acknowledgements

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Table I.1 – Indicator and weight setup

Group	ω_i	Sub-group	ω_i	Indicator	ω_i
Social	0.333	General characterization	0.167	Total population (No. of inhabitants)	0.627
				Population density (No. of inhabitants/km^2)	0.280
				Old-age dependency ratio (dimensionless	0.094
		Accessibility	0.833	Population served by water systems (%)	0.327
				Population served by wastewater systems (%)	0.413
				Population served by wastewater treatment plants (%)	0.260
Environmental	0.333	Water	0.293	Consumption/intake (%)	0.745
				Treatment/Intake (%)	0.099
				Consumption/Treatment (%)	0.156
		Wastewater	0.293	Wastewater collection/Water consumption (%)	0.250
				Wastewater treatment/Wastewater collection (%)	0.750
		Wastewater - treatment facilities	0.293	Wastewater treated in WWTP (%)	0.833
				Wastewater treated in collective septic tanks (CST) (%)	0.167
		Solid waste	0.073	Total urban solid waste collected (kg/inhabitant)	0.089
				Total urban solid waste recycled (kg/inhabitant)	0.352
				Total recycled/Total collected (%)	0.559
		Electrical energy use - per capita	0.047	Total (kWh/inhabitant)	0.167
				Household (kWh/inhabitant)	0.500
				Agriculture (kWh/inhabitant)	0.167
				Industry (kWh/inhabitant)	0.167
Economic	0.333	Expenditure - ratios	0.203	Environmental/Total (%)	0.528
				Wastewater management/Environmental (%)	0.333
				Remaining environmental protection activities/Environmental (%)	0.140
		Expenditure - per capita	0.124	Environmental (€/inhabitant)	0.200
				Wastewater management (€/inhabitant)	0.600
				Remaining environmental protection activities (€/inhabitant)	0.200
		Revenue - ratios	0.063	Environmental/Total (%)	0.528
				WW management/Environmental (%)	0.333
				Remaining environmental protection activities/Environmental (%)	0.140
		Revenue - per capita	0.038	Environmental (€/inhabitant)	0.200
				Wastewater management (€/inhabitant)	0.600
				Remaining environmental protection activities (€/inhabitant)	0.200
		Revenue/ Expenditure	0.572	Environmental revenue/Environmental expenditure (%)	0.250
				Wastewater management revenue/ Wastewater management expenditure (%)	0.750

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