

Characterization of environmental impact on resources, using strategic assessment of environmental impact and management of natural spaces of “Las Batuecas-Sierra de Francia” and “Quilamas” (Salamanca, Spain)

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Received: 26 March 2013 / Accepted: 22 July 2013 / Published online: 3 August 2013
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Abstract A new procedure is proposed for joint strategic environmental assessment and environmental impact assessment using simultaneous characterizations in the protected natural area studied to analyse the importance and extent of the impact of human activities within this area on the various natural resources. GIS techniques were used to define territorial models, including environmental information criteria in thematic layers to facilitate environmental diagnosis in the early planning stages in the areas of concern or of higher quality for conservation at different working levels (municipal, district, provincial or national). Traditional conventional environmental impact assessment methods were improved, using spatial analysis to compare scenarios based on the spatial and temporal variability of the impacts identified and their evaluation. This method was applied to the natural space of Las Batuecas-S. de Francia and Quilamas, where in an initial stage the different anthropogenic activities (landfills, etc.) with the potential to cause direct (sewage waters, etc.) or

indirect (leachate, etc.) impacts were identified, using checklists and double-entry matrices to analyse actions likely to cause impacts, developing the cartography and identifying environmental impacts potentially damaging to the natural environment. Next, thematic and interpretive mappings were drawn up (surface water quality, aquifer vulnerability to pollution and vulnerability to municipal solid waste) to assess the effects upon resources (water, soil, air, etc.). Finally, by overlapping the impact identification and vulnerability mappings (municipal solid waste, pollution of aquifers and surface water quality) the impact characterization mapping was obtained, showing the absorption capacity of the different sectors to help the responsible bodies set out preventive and/or corrective measures. The essence of this paper is, in methodological terms, its use of two methods simultaneously (strategic environmental assessment and environmental impact assessment) in a protected natural area, allowing it to be extrapolated to any area where territorial management and planning studies need to be carried out.

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Keywords Strategic environmental assessment (SEA) · Environmental impact assessment (EIA) · Impact characterization · Geoenvironmental cartography · Protected natural area

Introduction

The impact of human activities on the environment has highlighted the need to regulate these activities in a sustainable manner taking into account the carrying capacity of the natural environment. A series of environmental tools: strategic environmental assessment (SEA) and environmental impact assessment (EIA) were studied to

ensure rational use of natural resources and the prevention and reduction of pollution effects and technological risks.

The EIA procedure sets out from the transposition of Directive 85/337/EEC (DOCE L175 1985) on the assessment of the effects of certain public and private projects on the environment in Spain with Royal Legislative Decree 1302 in 1986 (BOE 155 1986), constituting a prevention tool for certain projects in the natural environment. However, there have always been two inherent weaknesses in the EIA process: the first is that the multidisciplinary team responsible for drafting the EIA (environmental impact identification and assessment) document is conditioned by the constructor, who pays for the study with the aim of it being positive, in other words, that the Environmental Impact Statement is favourable.

The second weakness is that a basic aspect of EIA consists of alternatives regarding the location of the project, design of facilities or the possible vulnerability of the territorial sectors proposed in the technical project. The problem arises when this land has previously been declared by local planning regulations as building land, with the developer alleging the said legislation so that environmental management requires preventive, corrective and/or compensatory measures, but not prevent the development of such activity in this territorial sector. This weakness is particularly important in areas of high natural quality, as the environmental agency does not participate in territorial land use planning, which comes almost entirely under the jurisdiction of municipal and urban planning administration.

The intense development of human activities over the last century has led to a significant deterioration in the environment, and the impacts of this unsustainable development has given rise to the emergence of a social awareness of the need to protect the environment from human activity. To this end, in Directive 2001/42/CEE (DOCE 197 2001) on evaluating the effects of certain plans and programs on the environment, strategic environmental assessment (SEA) was introduced as a key environmental prevention tool to make sustainable development the definitive aim of planning.

In 2006, Directive 2001/42/EEC was transposed in Spain by Law 9/2006 (BOE 102 2006), allowing environmental criteria to be taken into account in addition to the technical, economic and social factors which prevailed in the allocation of land in the territorial planning stage, and determining that the various Spanish municipalities should undertake an SEA considering all the environmental parameters, natural resources and areas of high natural value, with approval being bound to other rulings such as land use or urban planning regulations.

Through the application of territorial planning (environmental, urban, socioeconomic, etc.) the foundations for

subsequent development will be laid, especially in natural areas, where the more traditional and ecological human activities tend to be encouraged, being deemed more sustainable.

This paper proposes a combined procedure using tools from the first procedure (SEA) and impact characterization methods from the second (EIA). This working method allows the steward of a natural area to analyse the environmental impact of existing activities on resources (water, soil, etc.) as well as those predictable in the draft stage.

For the SEA process, mapping methods consisting of graphic techniques implemented in geographical information systems (ArcGis 9.3) are used. Integration of different thematic layers of environmental information from the same sector to assess the natural quality and vulnerability of the environment has been studied by several authors and institutions (Von Seht 1999; Agudo González 2004; Dirección General del Medio Natural 2005; European Commission 2006; Ramírez Santigosa et al. 2007; Valvueda Puebla et al. 2007) and its importance for SEA is highlighted by the European ENPLAN project with the Strategic Assessment Guide for plans and programmes with environment impact. In Ireland, this methodology has been put into practice using algebra from thematic maps of various parameters to establish the biodiversity of different land areas (González del Campo et al. 2007). GIS techniques have been implemented quickly and effectively in environmental assessments (Chan and Easa 2000; Joao 1998; Afgrawal and Dikshit 2002) for their ease of use in spatial analysis of location and valuation of natural resources as well as in relevance, quality and vulnerability studies.

Complementary methodologies are also employed in the EIA process, such as checklists or reviews, numerical methods for quantitative assessment using weighted cause–effect matrices and qualitative assessment methods for attributes. These methodologies have been widely tried and tested and are used by different authors in different countries (Leopold et al. 1971; Conesa Fernández-Vitoria 1997; Gómez Orea 1998; Petts 1999a, b; Glasson et al. 2002; Canter 2003; Wood 2003; Morris and Therivel 2004).

Methodology

This methodology is applicable to any territorial space in the world, including areas of great natural value as well as more common spaces of lower environmental quality. Moreover, the methodology is not conditioned by territorial limits and can be applied in a protected natural area, the whole of a municipality, county and/or province or at national level. However, in this case, it must be stressed that a methodology applicable in general terms is generated

by analysing a local territorial sector, such as the natural spaces of Las Batuecas-Sierra de Francia and Quilamas, to the south of Salamanca Province in the Spanish Central System (Fig. 1 left). Producing it in a sector with a greater land area would be more complex, given the absence of thematic mapping, which in our case had to be developed.

The methodology used (Fig. 1 right) consists of applying mapping procedure with GIS techniques to quantify the environmental effects upon natural factors as water, soil, air and landscape, and using EIA methods as matrices (cross-actions and factors) and assessment of attributes (persistence, extension, synergy, etc.).

Environmental impact analysis is performed at an early stage, identifying the different anthropic activities (landfills, etc.) likely to have an impact on the environment either directly (waste, etc.) or indirectly (leachate, etc.) and drawing up maps identifying specific points, lineal or areal environmental impacts (Fig. 2).

In the second place, field cards or checklists are drawn up, identifying the actions and factors (Fig. 3a), where each activity and discharge point is characterized by its intrinsic (geology, geotechnical, surface hydrology, hydrogeology, topography and vegetation) and extrinsic (type of waste, toxicity, persistence, drainage, lining, size, management, etc.) features to assess (high–medium–low–null) the contamination risk qualitatively at each site and determine which factors will be affected (water, soil, air, landscape, geomorphology, active processes and socioeconomic elements).

For the *identification of actions*, various activities are studied, analysing the actions from the different phases (construction, exploitation or running and abandonment-restoration) to detect the impacts that may result. These actions are determined, as far as possible, by quantitatively assessing their magnitude (area affected, volume of waste, etc.), flow (flow discharge, flow of vehicles, people, etc.), spatial location coordinates and the time that each action takes place. Several approaches can be used to identify these actions (checklists, consulting expert panels—Delphi method—comparative scenarios, general cause and effect matrices, interaction matrices...). In the current work, checklists were used that are practical in field work and easy to interpret for cartographic representation. The selected actions are significant, independent (to avoid duplication) and, whenever possible, measurable or quantifiable.

Identification of factors is carried out on the basis of an environmental inventory of the natural surroundings and their associated thematic mapping, establishing the different elements and their spatial characterization. In this way, the environmental factors likely to be affected are determined; for example, channels close to leachate ponds or geological heritage points near mining areas.

Once the actions of the different activities likely to cause impacts and the natural environmental factors that may be affected are known, these actions and factors are crossed in a double-entry matrix to establish the positive or negative effects (impacts), identifying the influence (single

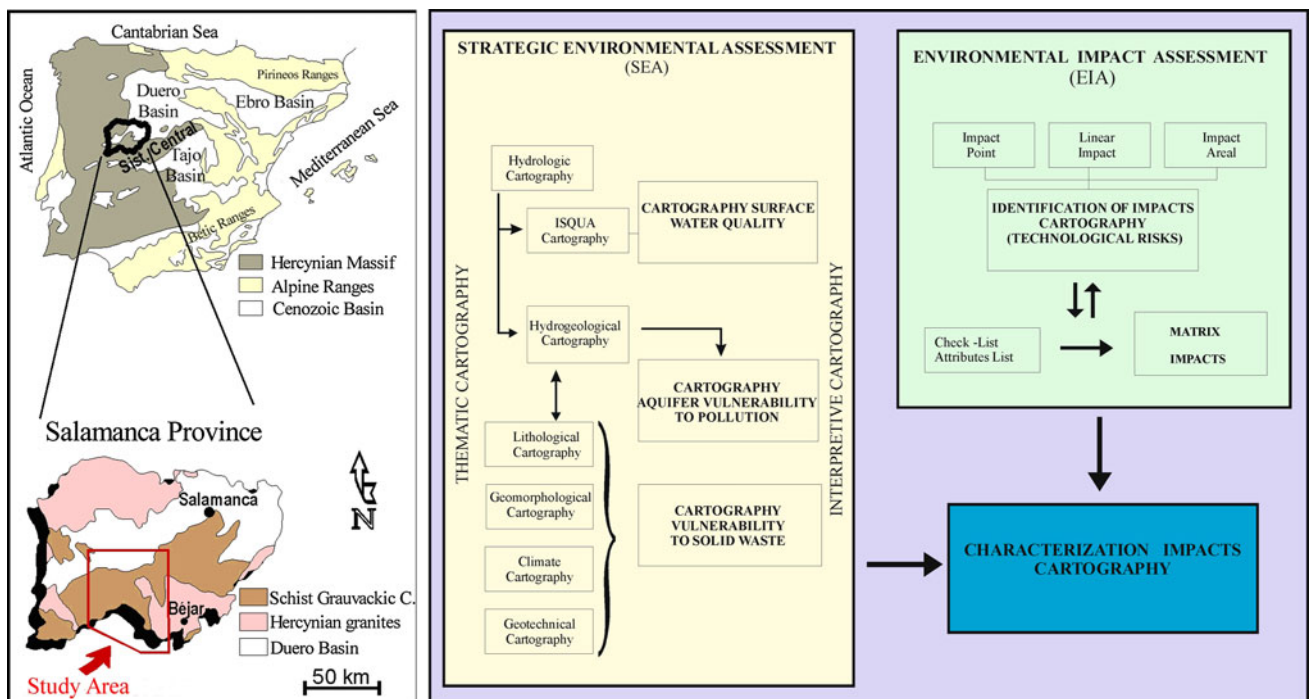


Fig. 1 Left study area. Right methodological diagram

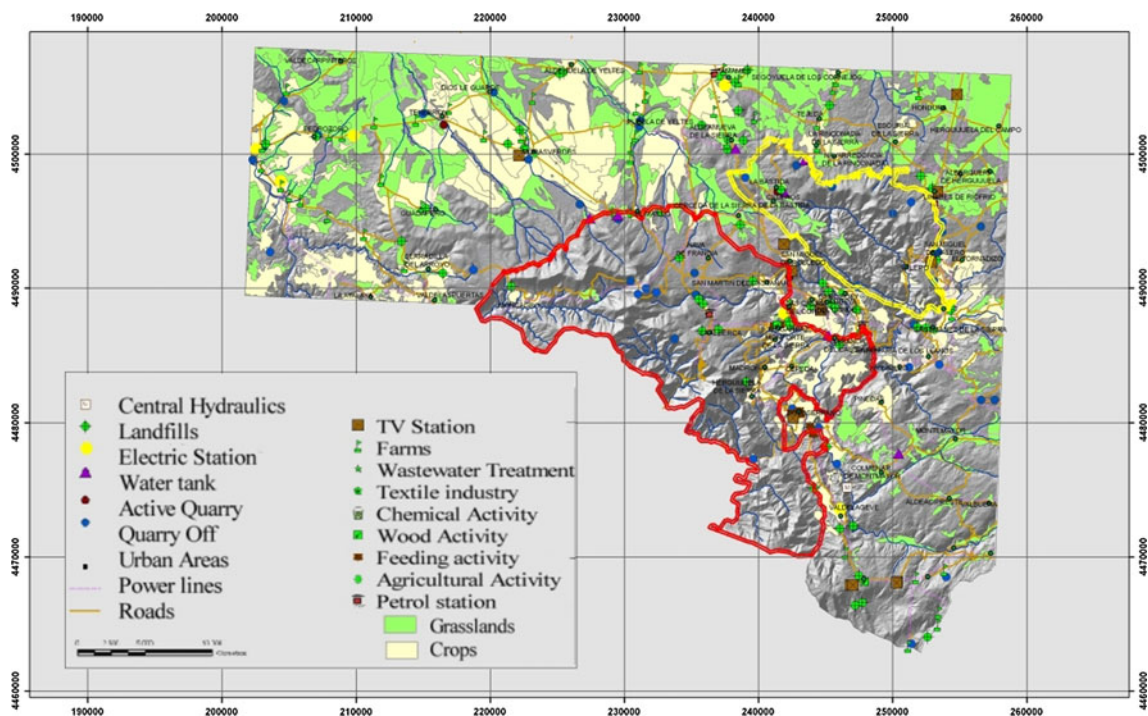


Fig. 2 Impact identification cartography

impacts, primary, secondary, direct, indirect, etc.) from when action is generated until its influence reaches the natural environment and mankind. In this section, the degree of impact is set out (cross = action \times factor = effect), classifying the crosses that give rise to important (x), moderate (0) and zero (-) impacts (Fig. 3b).

Qualitative assessment of the importance or incidence and magnitude of impacts is performed only for significant impacts (x), as it is assumed that moderate impacts are reversible on their own, reaching their initial state without human intervention. This qualitative assessment takes into account a series of weighted attributes that allow a final impact value to be assigned for each effect, which together generate the final overall impact of the activity on the environment (Fig. 3c).

On the one hand, the *Importance or Incidence* of impact was calculated from the impact matrix (cause–effect crossover) and the alterations were characterized in terms of attributes that determined the form and degree of the impact. The following attributes were used:

Sign (\pm): the impact caused may be considered beneficial (+), damaging to the environment (–) or predictable, but is difficult to rate without detailed studies.

Effect: refers to the cause–effect ratio, i.e., how the effect on a factor is manifested as the result of an action. it may be indirect (1) or direct (3).

Accumulation: a progressive increase in the manifestation of the effect, when it persists continuously or the

action that generates it is repeated. it may be simple (1) or accumulative (3).

Frequency: refers to the regularity of the effect manifestation and whether it is cyclical or recurrent, unpredictable over time or constant over time. The event may be discontinuous (1), periodic (2) or continuous (3).

Persistence: refers to the time that the effect is expected to last as of its appearance. It may be expressed in units of time, usually years, and is usually considered to be temporary if between 1 and 10 years, and permanent if it exceeds 10 years. The impact can be regarded as transient (1), temporal (2) or permanent (3) as of the moment the action takes place.

Reversibility: refers to the possibility of the affected factor returning to the initial status or zero state without intervention once the action upon the environment ceases, and if possible to the time this would take to achieve. If <1 year, it is considered short term (1); between 1 and 10 years, medium term (2); and over 10 years, or if it is impossible (3) to reconstruct the factor, it is considered long term.

Synergy: envisages strengthening of two or more simple effects. The simultaneous presence of several agents or actions poses a greater environmental risk than the sum effect of individual incidents. It can be simple (1), synergistic (2) or very synergistic (3).

Recoverability: describes the possibility of total or partial reconstruction of the affected factor as a result of

Fig. 3 **a** Checklist; **b** impact identification matrix; **c** valuation matrix and characterization matrix

Sheet Number: Point: UTM coordinates: Topographical Map Number:	Information Sources: Public Agency: Others:	
Toponymy Place / Town:		
Water: Water Treatment Sewage Wells / boreholes / springs Flood Zones Pollution: Chemical (colour, foam ...) Physics (temperature...) Biological (organic matter ...)	Soils: Texture Structure Pollution (faeces, oil, ash Others.	
Waste: Controlled Landfill: Uncontrolled landfill: Waste Debris: waste incineration:	Landscape: Visibility (view shed) Landscape quality (degraded landscapes, altered ...) Fragility Landscape Distances to urban cores Accessibility Human frequentation	
Geology: Substrate Lithology Fractures / jointing Permeability Compaction / cementation	Geomorphology: Geomorphological Unit: hillside, valley ... pending curvature	
Socioeconomic: Population Number Place names, cemeteries, hospitals...	Industrial activity is subject to: Environmental Reports Environmental Impact Studies Environmental Audits Environmental Management Systems	
Mineral Resources: Active quarries / Mines Quarries Gravel Others.	Renewable energies: Solar parks Wind farms hydraulic power Others.	
Linear infrastructure: Power lines: Water Supply Roads, forest tracks Pipelines Railway Line Others:	Sketch situation	
Cultural Heritage: Buildings (castles...) Bridges (Roman times ...) Others:		
Industry: Location: Typologies: Land, Timber, chemistry, silk, meat ...		
Biotic Resources: Reforestation Fire / Area affected Firewalls Hunting and fishing Crop ...		
Singular points: Natural Sightseeing Recreation Areas Recreational Activities Viewpoints, Camping ... Spills:		
Typologies (industries, pesticides, oil ...) Atmosphere: Sounds / smells / dust Natural Hazards: (landslides, mudslides, soil erosion, others. Vegetation: density / diversity / endemism ... Fauna: species / diversity / endemism		
Date:		Photos / Panoramics:
Distance travelled:		

the project, i.e., the possibility of returning to the initial conditions before the action through human intervention. it can be immediate (1), medium term (2) or unrecoverable (3).

On the other hand, the magnitude is calculated by defining attributes that quantify the magnitude of the condition and extent of influence of the activity. These attributes are:

Intensity: the degree of destruction of each impact on the environment. It may be low (1), medium (2) or high (3) as the impact affects the entire environment.

Extension: refers to the theoretical area of influence of impact in relation to the project environment (% of area around the environment in which the effect occurs). This can be considered isolated if the action produces a localized effect (1); partial (2), a level between the previous

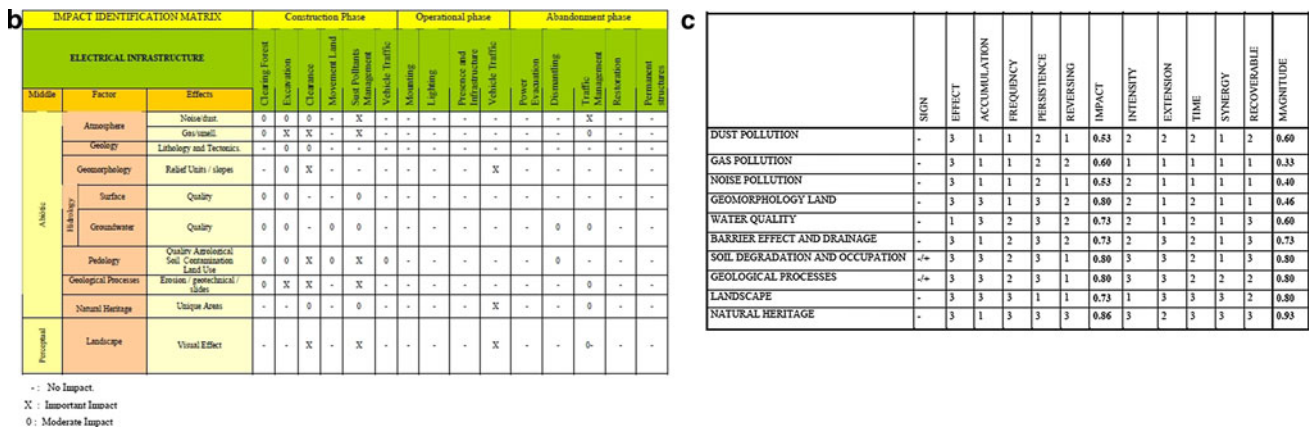


Fig. 3 continued

situation and the following; or extensive (3), if the effect cannot be located within the project environment.

Time when the impact occurs: refers to time from the onset of action and the onset of effect on the environmental factor considered. This may be long term (1), short term (2) or immediate (3).

Synergy: envisages strengthening of two or more simple effects. The simultaneous presence of several actors or actions poses a greater environmental impact than the sum effect of individual incidents. It can be simple (1), synergistic (2) or highly synergistic (3).

Recoverability: describes the possibility of total or partial reconstruction of the affected factor as a result of the project, i.e., the possibility of returning to the initial conditions before the action through human intervention. It can be immediate (1), medium term (2) or irretrievable (3).

In third place, a series of thematic and interpretive maps is drawn up to assess the impact of different human activities on water resources:

1. Surface water quality mapping (Fig. 4), where on the basis of field samples, the quality and/or degree of pollution of surface waters is determined by means of the Simplified Water Quality Index (ISQUA) (De Bustamante 1989), which is a dimensionless quantity that allows operation with very few analytical parameters, while providing guarantees in the results (Cubillo 1986). This index is defined by five parameters and its expression is $ISQUA = T(A + B + C + D)$, where T is a function of the temperature of river water measured in °C. A, its value between 0.8 and 1, is function of oxidizability and corresponds to the oxygen consumed in oxidation with MnO_4K at boiling point in an acidic medium. It includes the organic content, whether natural or not, and varies from 0 to 30. B is a function of suspended matter that can be separated by filtration; this parameter varies between 0 and 25. C is a function of oxygen dissolved in water and varies from 0 to 25;

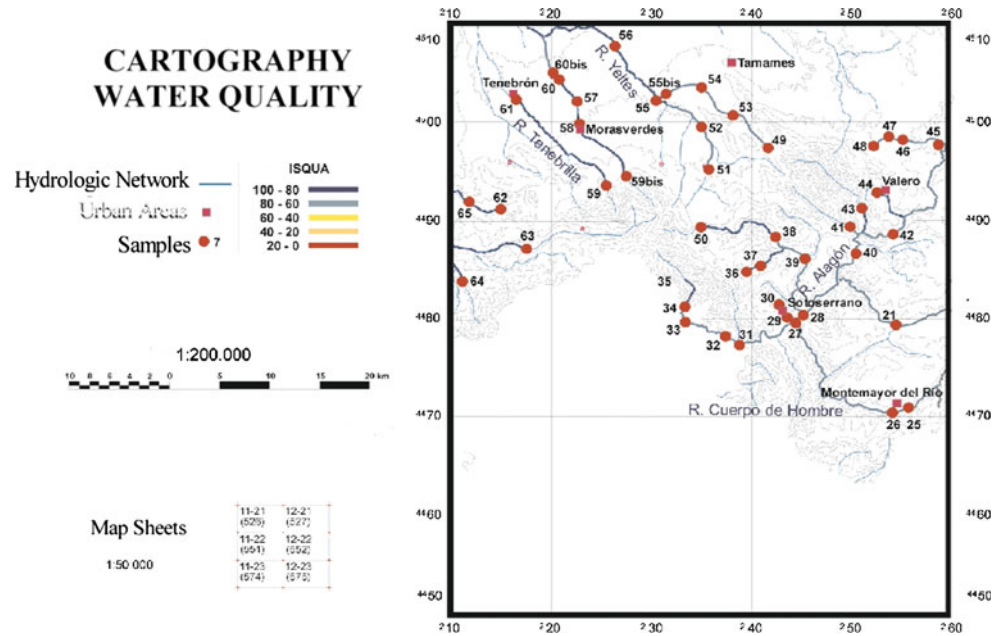
D is a function of electrical conductivity at 18 °C and varies between 0 and 20. The range of values of this index ranges from 0 for very bad values to 100 for optimum values.

To draw up the mapping, a series of sampling points was selected in which simple samples were collected and the following analytical parameters were determined “in situ”: temperature, dissolved oxygen, conductivity and pH. In laboratory, the biological oxygen demand— DBO_5 -, chemical oxygen demand— DQO -, suspended solids, total organic carbon (TOC) and nitrates (NO_3^-) were measured. (De Bustamante et al. 2002).

2. Aquifer vulnerability to pollution mapping (Fig. 5 top) was drawn on the basis of the mapping of hydrogeologic units, based on their lithological features and hydraulic parameters. Seven hydrogeological units are distinguished (Fig. 5 top): granite unit (1) consisting of granite rocks with low–medium permeability due to alteration and/or fracturing; metasedimentary unit (2) consisting of slates, schists, greywackes and conglomerates with low permeability due to alteration; quartzite unit (3) formed of Armorican Quartzite and sandstone with medium–low permeability due to fracturing; carbonated unit (4) consisting of limestone and dolomite limestone breccias with medium permeability due to dissolution and/or fracturing; detrital unit I (5) consisting of arkosic sand, gravel and shale permeability and porosity with medium–high; detrital unit II (6) formed of conglomerates, gravel, sand and mud with medium–high permeability due to porosity; and finally the Quaternary unit (7), consisting of small stones and blocks with sandy-clay matrix and pebbles, gravel, sand and silt with medium–high permeability and porosity. (Fig. 5 down).

To represent the vulnerability to contamination of the different hydrogeological units, the GOD method was used (Foster et al. 2003). This approach mainly considers three factors:

Fig. 4 Surface water quality cartography



1. Hydraulic containment level. (G).
2. Occurrence of overlying substrate (O). It is estimated based on the lithology and degree of consolidation of the unsaturated zone or confining layers.
3. Distance to groundwater level (unconfined) or ceiling of the aquifer (confined) (D).

While drawing up the thematic mapping for the study zone, the presence of a small number of points was observed that provided rigorous information with in-depth data on the saturated zone. From this fundamental data, we were able to generate isoline maps by GIS techniques, allowing us to show the variability of the distance from the surface topography of the water table and assess the vulnerability in terms of the ease with which a pollutant could reach the water table at some distance, and so allow us to insert this parameter (D) into the GOD method. Given the unreliability of a correct interpolation, not being a representative sample and the amount of data, the GOD method was used according to the mapping of hydrogeological units, estimating the aquifer depths.

The results obtained with this methodology are grouped into five possible classes of vulnerability (Fig. 5 bottom), as follows: negligible, low, medium, high and extreme. Applying the process to the study area, it was noted that were only three types of vulnerability: extreme vulnerability (0.9) in the carbonated unit (4), high vulnerability (0.5–0.7) in the Quaternary unit (7) and average vulnerability (0.3–0.5) in the other units: granite (1), metasedimentary (2), quartzite (3), detrital units I and II (5 and 6).

1. Vulnerability to municipal solid waste map (Fig. 6), obtained by GIS techniques (ArcGIS v.9.3) from the

thematic mapping of the parameters that influence the vulnerability: lithology, surface hydrology and hydrogeology, geomorphology, climate and geotechnics. The lithological parameter takes into account the distribution of the lithology of the different sectors of the protected natural area (Martínez-Graña et al. 2004). The different factors to be taken into account for the location of a landfill are rocky substrate, structure (fractures and joints) and surface features (texture, compaction, etc.). The surface hydrology and hydrogeology parameter analyses these characteristics, taking into account the type of permeability (K) based on the porosity (intergranular and fissure), solubility and fracturing (Martínez-Graña et al. 2004; Sanz et al. 2005). The limit values for waste sites are taken into account: non-hazardous waste landfills, $K \leq 1 \times 10^{-9}$ m/s; and landfills for inert waste, $K \leq 1 \times 10^{-7}$ m/s. (Williams 1998).

The geomorphologic parameter helps us understand the morphological characteristics that affect the substrate, the surface formations and the degree of slope to be considered for its location (Martínez-Graña et al. 2006). This mapping will help us to identify the active processes (risks) that establish the danger areas for landfill site or waste treatment facility location.

The climate parameter analyses the rainfall distribution, as it favours the formation of leachate that may pollute waters and soils. The mapping used is pluvial aggressiveness (Martínez-Graña et al. 2004), drawn up based on the modified Fournier index (Fm). This map helps to assess the effect of rain on the landfill and its impact on restoration (revegetation of slopes). Finally, the geotechnical

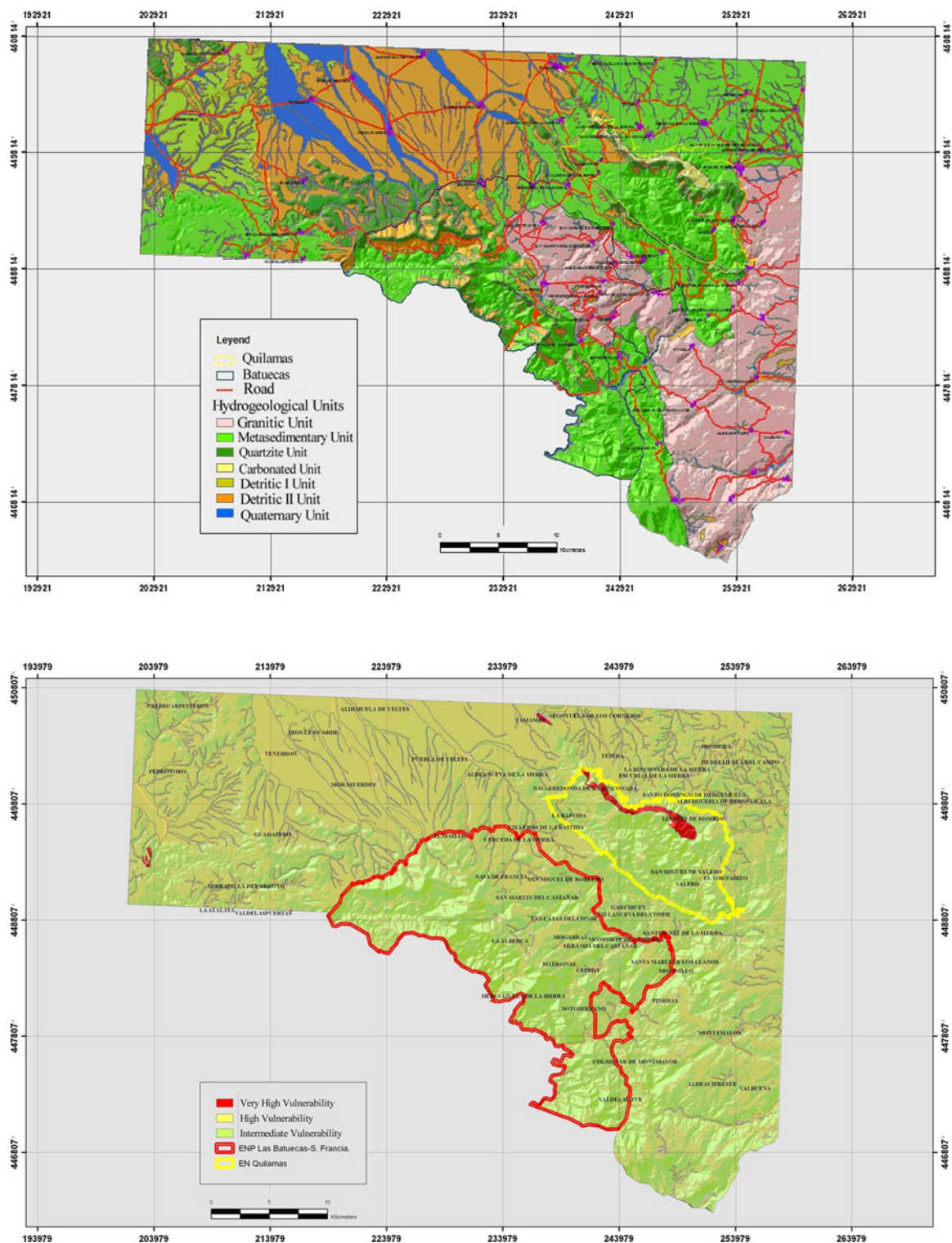


Fig. 5 Top hydrogeological unit cartography. Down cartography of aquifer vulnerability to pollution

parameter allows for proper planning in the operational phase and restoration of a landfill to analyse the existing loan materials in the area to be used in these tasks. It is,

therefore, necessary to know the rippability of the materials for possible covering or to be able to generate a basin to achieve a longer working life. This variable was obtained

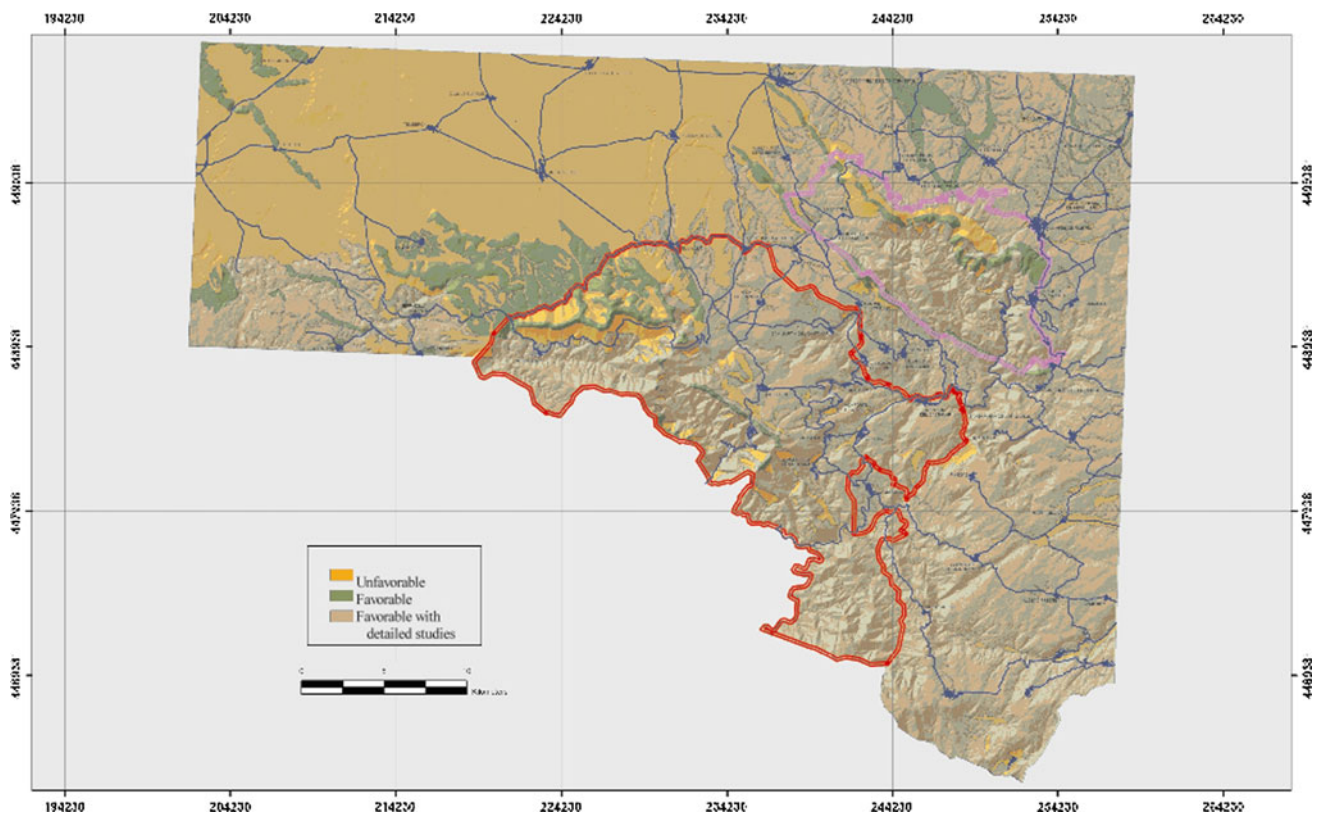


Fig. 6 Cartography of vulnerability to municipal solid waste

based on the lithological, geomorphological and hydrological features.

Results and conclusions

This paper validates a combined SEA and EIA procedure, which examines the impact of the environmental vulnerability of the physical environment (surface water, groundwater and waste) using thematic maps (surface water quality, aquifer vulnerability and vulnerability to solid waste) based on different parameters that directly influence the vulnerability (geomorphology, slopes and surface formations, geotechnical, hydrogeology, climatology, soil science, etc.).

To validate the procedure, it was applied in a local sector (natural areas of Las Batuecas-S. de Francia and Quilamas), which allowed extrapolation to other national and international sectors or other levels (regional, national), as the thematic layers methodology made it easy to implement. The use of this geographic information systems methodology allows better forecasts of vulnerability and interconnections of the different territorial sectors, due to the spatial nature of the environmental data, its analytical power and synthesis by means of algorithms (visibility calculations, guidance). Moreover, the increased availability and

accessibility of digital information currently supported by the recent INSPIRE Directive (DOCE L108 2007) will greatly improve the application of this method to all environmental factors (landscape, geology, soils, vegetation).

From the impacts identified in the study area and shown in the identification map (Fig. 2), it can be seen that one of the major environmental impacts on these natural areas is the abundant presence of scattered dumps and landfills. Another effect on the landscape, widely dispersed but important at specific points, is the presence of TV repeaters, electrical power plants (Fig. 2) and mobile phone towers. In addition, farming operations are distributed near roads, some at a safe distance from other urban areas and others too close to avoid disturbing the population (smells, noise). Industrial activities (timber, textiles, food processing, feed mills, slaughterhouses) and livestock are concentrated in or on the periphery of urban areas with accumulations of organic waste.

Analysing interpretive maps, it can be seen that the surface water quality map (Fig. 4) shows that some rivers (Alagón, etc.) have a lower water quality than their tributaries. This is due to discharges of urban (Sotoserrano, Valero, San Miguel de Valero) and industrial (food industry, agriculture) wastewaters into the river channel which lowers the water quality, as these effluents are not processed previously. The lower reaches of the Yeltes

River waters present a slight drop in quality caused by mining operations in the fluvial plains and terraces, creating an increase in turbidity (suspended solids) and incidents of discharges from mining activities (processes and machinery).

The map of aquifer vulnerability to pollution (Fig. 5 down) shows extreme vulnerability in carbonate outcrops due to limestone and dolomite dissolution processes. These aquifers have very high vulnerability due to the direct and rapid spread of pollutants in fissures and cavities in carbonate rocks. Land use planning in these sectors should not allow the introduction of polluting activities, such as solid waste landfills (municipal and/or industrial) or surface and underground liquid discharges. Unsuitable farming and livestock practices should be monitored and the land must be restored in the event of active or abandoned mining activities. Areas with high vulnerability correspond to Quaternary materials, whose aquifers are highly vulnerable to the entry of pollutants from rivers, streams or direct infiltration. Above all, this pollution affects free alluvial

aquifers, since their self-purifying potential against organic and bacteriological contamination is limited. As in the previous case, the installation of human activities likely to affect the quality of aquifers containing these Quaternary formations should be closely monitored. Finally, the average vulnerability is located in areas of zero and low permeability alternations (detrital units) with a high bacteriological purification capacity but low for chemical pollutants, and in second place alterations may occur in impermeable igneous and metamorphic soil areas, with pollution being limited to surface waters and sectors of cracking and alteration.

The map of vulnerability to municipal solid waste (Fig. 6) shows the sectors which are favourable or unfavourable for landfill location in principle, and sectors that may be suitable with detailed studies (ED), such as determining the thickness of the saprolite and degree of alteration in granitic areas. These parameters are used to define the areas of greatest territorial capacity for this type of human activity (landfill) currently located near urban areas.

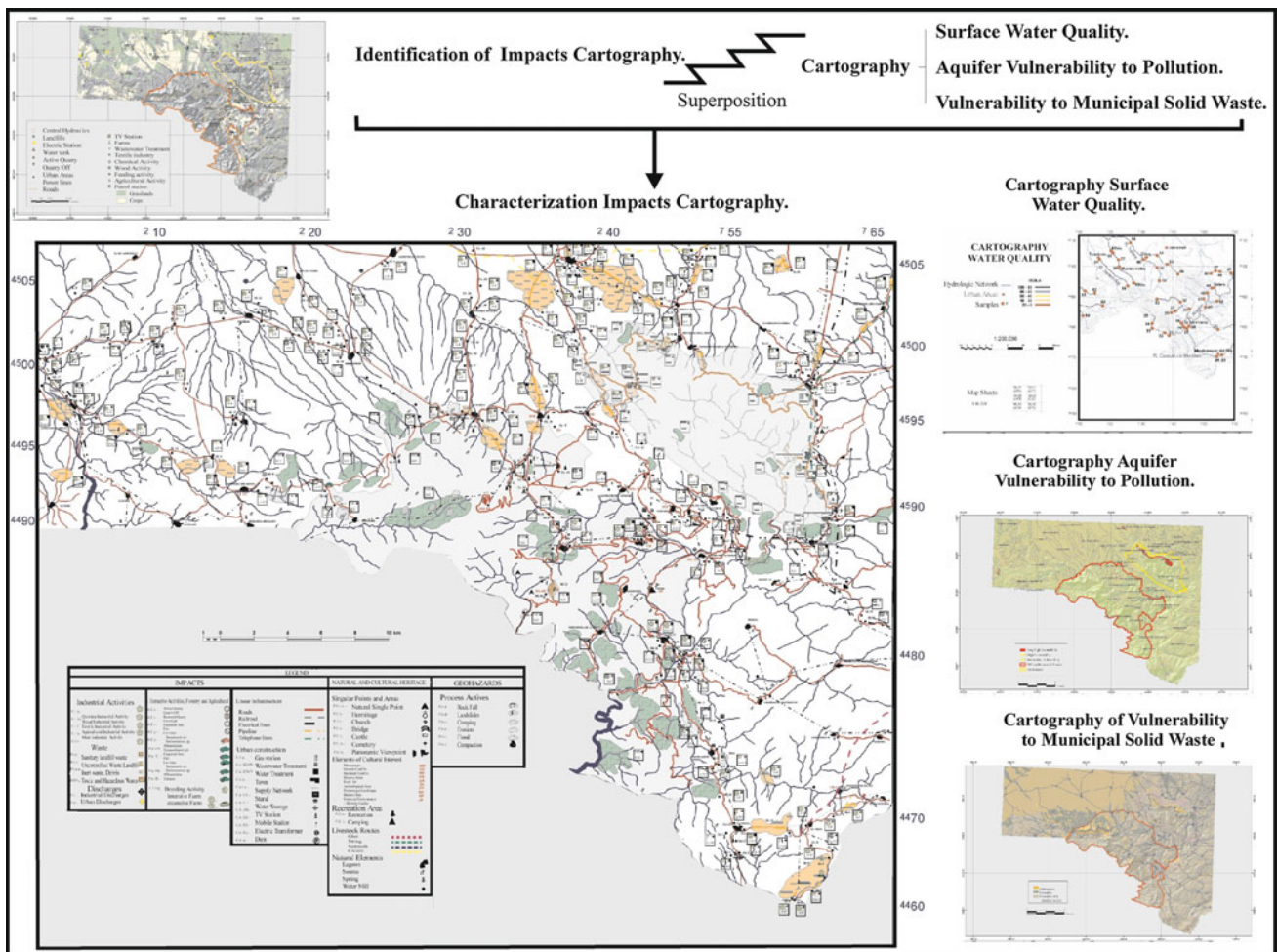


Fig. 7 Impact characterization cartography

Finally, the impact identification map (Fig. 2) is superimposed on the surface water quality (Fig. 4), aquifer vulnerability to pollution (Fig. 5 down) and vulnerability to municipal solid waste (Fig. 6) maps, noting the impact of different human activities and their problems in each area and their potential impact on different factors (water, soil, air, landscape, geomorphology, active processes,

socioeconomic issues and patrimony). The impact characterization map (Fig. 7) thus obtained shows the hosting capacity of the different locations for human activities, indicating the variety of impact types (industrial, agricultural, livestock, landfills, etc.), the degree of impact (compatible, moderate, severe, critical) and the factors likely to be affected (Fig. 8). Severe impact from livestock

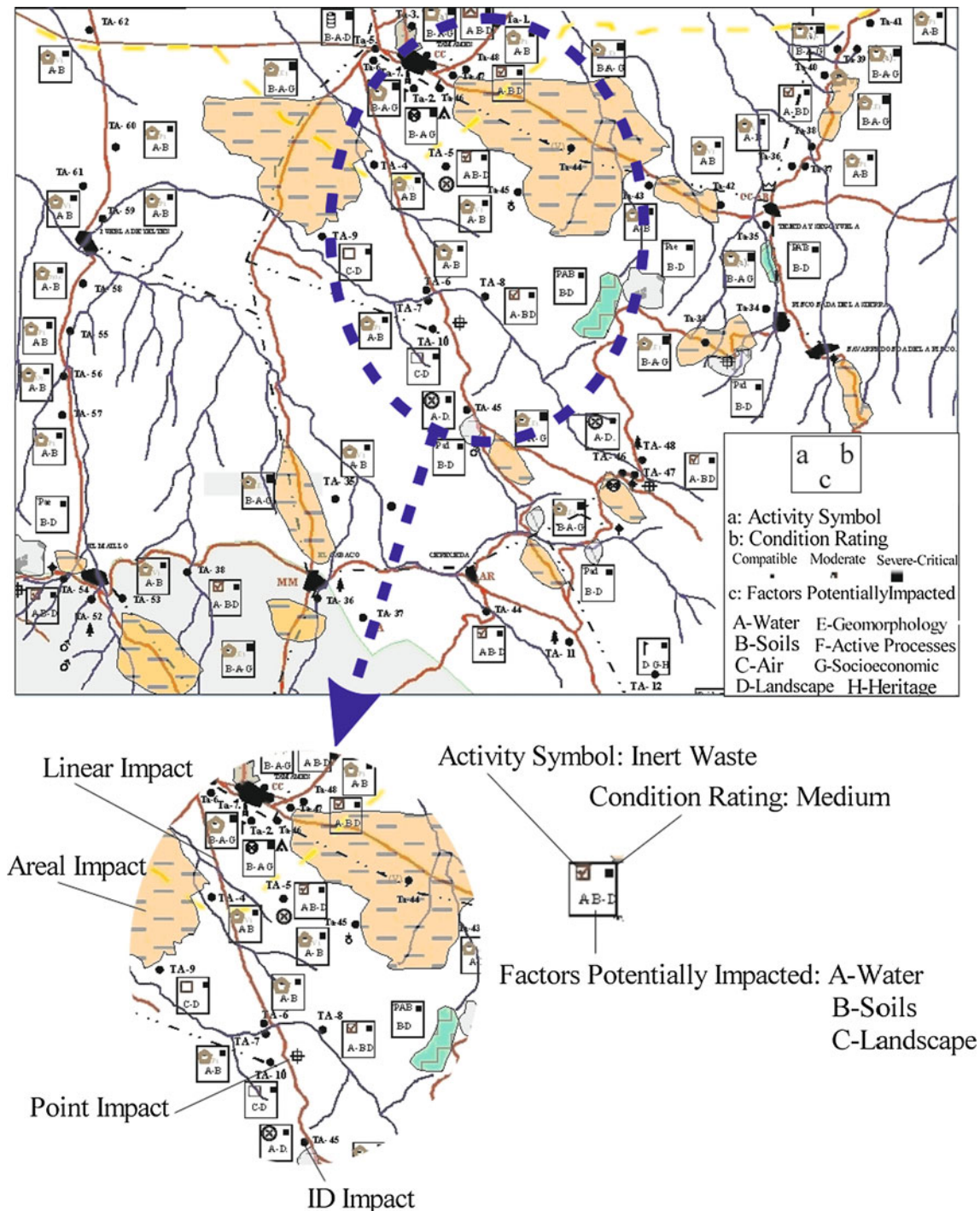


Fig. 8 Details of cartography and its interpretive scheme. The legend for the symbols of the different activities is shown in Fig. 7

activities is observed in the soil and water resources and a moderate degree of landscape impact is due to the presence of electrical and communication infrastructures.

The importance of this methodology in natural spaces of high environmental quality, such as the Las Batuecas-S de Francia and Quilamas natural areas is widely acknowledged, but in the absence of a strategic environmental assessment prior to 2006, some protected natural areas currently have potentially impacting activities in situ (industrial, agricultural, livestock). The impact characterization map therefore establishes the vulnerability and anthropogenic load in each sector of the natural area to facilitate analysis of the impact on the environment for future action, taking synergies with existing activities into account.

The GIS techniques allow the use of information available in digital format that is compatible to and implementable in different databases (ArcGIS 10.1, Grass, MiraMon). By applying the procedure proposed in this paper, dossier management is improved since the vulnerability of each sector is known, simplifying the issues to be addressed by the multidisciplinary team through an easy and concise overlap analysis by the environmental administration technician. Ultimately, compared with the methodologies that have been developed in this field, this procedure improves pre-consultation (scoping) in Strategic Environmental Assessment, allowing a multidisciplinary approach that helps place the location of each activity in terms of the natural quality of each sector (impact characterization–environmental assessment maps) in the early stages and establishes the complexity of the possible effects in combination with other human activities (impact identification–environmental impact assessment maps), providing an environmental diagnosis based on the detection of those elements and values of the natural environment worthy of protection and conservation.

As seen in the natural space of Las Batuecas-S de Francia and Quilamas, the application of this procedure improves the quality and integration of thematic environmental information, enabling an economic and time-saving fast track approach, since the authority of any natural area can determine “a priori” which factors are to be studied in more detail and even which actions or elements of the activity can be corrected beforehand.

This new methodology is of great interest, as it provides reliable results quickly and is economically suitable for application both in poorly resourced rural areas and the management of protected natural areas, constituting a useful tool to determine the status of the natural environment and in particular to analyse the impact on water quality and identify sources of pollution, setting the course for subsequent studies into identification of problems and their actions.

Acknowledgments We acknowledge the projects CGL2008-03998/BTE, CGL2008-04000/BTE and SA041A08 (JCyL).

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