Extended Abstract


The main objective of this work was to evaluate the zoning methodology of the legal socio environmental restrictions towards the soil use and occupation, using geoprocessing tools to subsidize the choice of the railroads tracings, through the case study of the EF-118 via, Nova Iguacu (RJ) – Cariacica (ES).

Among the specific objectives are: analize the concepts of geotechniques and the application of spacial analysis tools as support to the land management, figuring out the planning and environmental zoning, identify and analyze the legal socioenvironmental spatial data related to the theme and analysis models of data to environmental zoning from the case study of the railroad Nova Iguacu (RJ) – Cariacica (ES), for identification of legal socio environmental restrictions to the railroad tracing.

In general, the research takes place in the Brazilian context, where the country sees itself as the 7th world’s largest economy; the 8th world’s largest consumer market, still being world’s natural resources supplier – standing out Iron and eucalyptus pulp.

In this scenario, the transportation network expansion is fundamental; however, currently the Brazilian transportation system finds itself before two paths. On one side a strong modernization movement in the companies, which demand increasingly efficient, trustable and sophisticated logistic services, in order to keep competitive in a world that has globalized, and where logistic is, more and more determinant to business success. On the other side, a set of structural problems, that distort the Brazilian transport matrix and contribute to the quality services commitment, the operators financial health and mainly the country’s socio economic development. (Wanke e Fleury, 2006)
In 2011, the transport matrix was divided in: road, with 59% of participation; railroad, with 24% of participation; water, with 13% of participation; air with 0.3% of participation and pipeline, with 3.7% of participation.

The railways represent today one alternative to face the Brazilian transportation logistical grip, principally due to its advantages over the other models, being ideal to large volumes of cargo, besides being the most indicated to long distances and to low value-added products – Commodities - transportation.

This way, the current study was motivated by the railroad network that should expand in a scenario where the environmental issues are becoming increasingly important. Consequently, it is necessary a better understanding of the territory and the risks associated to its use.

As a way to reach this understanding, the spatial analysis tools are essential for the planning of the land use to be aligned with the legal basis of environmental conservation and preservation, subsidizing the elaboration of the environmental zoning, which allows the establishment of areas reasonably favorable to the development of economic activities. All these activities are intended, among others, to open room for the entrepreneur to be able to visualize more adequate locational alternatives, avoiding future complications in the environmental licensing.

Such tools rely on theoretical and methodological references, which base the construction of new perspectives and interpretations of the region from public socio and environmental spatial data, being used as input. This new interpretation of the territory was built with the help of four main themes. They are: the Brazilian Environmental Legislation, the Environmental Planning, the Environmental Zoning and the Geotechnologies.

This way, the starting point for the goal to be achieved in this current study was the analysis of the Brazilian environmental legislation, which holds social aspects, physical environment aspects and biotic aspects. The legislation guided
the spatial socio-environmental data collection in order to map the main use restrictions and land occupation provided by law. Through literature search, the Brazilian environmental legislation was collected, for identification of the potential restrictions and limitations of land use and occupation and for construction projects.

In relation to the Brazilian Environmental Legislation, considered one of the most advanced in the world, are highlighted, in this research, those which are about topics related to the aims that are to be reached, that is, the ones which have objectively straight relationship with the land management and which, consequently, can be represented in the space.

Such legislation is the result of an accumulation of other experiences related to the regulation and orientation towards conservation and preservation of the environment. Among these experiences stands the “National Environmental Policy Act (NEPA)”, North-American regulation of 1969, which instituted the Environmental Impact Assessment/EIS, whose efficiency echoed, among other aspects, in the effectiveness of the civil society participation in the decision process towards the environmental viability of the projects. Also, by influence of the Stockholm Conference, the repercussions from this same Conference soon sounded, and, already in the 70s, large-scale projects, under the screen of multilateral funding agencies, were submitted to the Environmental Impact Assessment, as the case of the hydroelectric power plant of Sobradinho, first enterprise to undergo environmental evaluation in Brazil, in the year of 1972.

The experiences in environmental impact assessment followed up in the 70s, culminating in the consecration of that regulation as a tool of the National Environmental Policy, Law Nº 6938/81, in association with the licensing of the activities using environmental resources considered effective or potentially polluting. Besides this law; Law Nº 9605/98, which deals with Environmental Crimes, Law 9.985/2000, which instituted the National Protected Units System; Law 12.651/2012, which establishes the Forest Code; the Resolutions CONAMA 001 and 237, which orient the Environmental Licensing of potentially environmental modifying activities and the Ministerial Decree Nº 419, which
regulates the performance of organs and entities of the Federal Government involved in the Environmental Licensing, such as FUNAI and Palmares Foundation, were considered to the analysis elaboration performed to reach the intended goal of this research.

Other concepts that underpinned this research now developed were those related to the Environmental Planning, presented by authors like CONYERS and HILLS (1984), BARRETO (2000), OREA (1994), VAN LIER (1994), VAN DE LAAK (1994), DORNEY (1989), CHRISTOFOLETTI (1999), PARTIDÁRIO (1999), among others, as a way to understand the elaborating planning process of the land use in a broader way.

Seeking the concepts of environmental planning for answers for the intended goal, it is noticeable that such concept is increasingly inserted in a broader planning context, which is the one of land use and occupation, not only in Brazil, but in the world. This way, the environmental issues are always associated to the territory management and need to be considered in the decision taking by the actors responsible for the public as well as the private space managing.

Accordingly, having in mind the Environmental Planning as environment integrated analysis, the planner should never forget that the most important parts involved in this process are the society, nature and the dynamics of mutual influence in the interaction between both of them. Society, using an ecosystem, whatever ecosystem, modifies its structure and functioning, causing impacts that can be irreversible. However, this can be avoided or minimized through the previous knowledge and planning of the use of the ecosystem. The planning should be able to produce and define norms of land use and occupation and to establish clear guidelines for sustainable development and conservation of the environment, suggesting alternatives to reverse the process of social and economic environmental deterioration.

This way, the planning is a continuous process that involves decisions or choices about the available resources with the objective of reaching specific goals somewhere in the future (CONYERS and HILLS, 1984), helping the decision
taking or choice, involving the various alternate ways, and which the best one is to reach those same goals, with the aim of establishing uses or allocation of resources, which can be natural, human, financial or infrastructural.

Consequently, the planning can establish alternate ways to reach the outlined objectives, involving realistic goals, political decisions and popular participation. This way, the Planning is made up focused in the future, which involves forecasts or approximate predictions of what can happen and, more specifically, predicting outcomes of the alternative proposals, which determines the ones to be adopted.

In short, the Environmental Planning is the integrated analysis of the environment, taking into account the society, nature and the dynamics of mutual influence between both of them and should be capable of producing and defining norms of the land use and occupation, besides establishing clear guidelines for the sustainable development and conservation of the environment.

Therefore, in brief, the environmental planning seeks to establish the society acting limits in its relationship with the environment. So, it makes sense the effort in understanding the territory in which it is intended to act, projecting the actions that will be developed in the space, to forecast which the consequences of the human interventions are over the natural resources available and this was the reasoning line taken in the research exposed here.

To achieve the Environmental Planning, the tool of the Environmental Zoning is taken as a way to diagnose the territory in relation to its limits and skills. It is, therefore, a multidisciplinary research balanced, quantitative, to be developed with analytical and systemic focus, orienting the review and/or elaboration of research policies and conservation and integrated handling of natural resources.

To ROSS (2006), the environmental zoning is an integrating process of technical-scientific disciplines, since he considers the environmental potentialities, seeking to establish a harmonious relationship between society and
nature, based on the spatial planning and on the development linked to the conservation policy.

DEL PRETTE and MATTEO (2006) briefly define the term zoning describing it as an action tool used by private agents and by the government since the constitution of the societies, with the aim of distributing the human activities around the physical space in an organized way.

The Environmental Zoning came up representing what would be a third line of thought, presenting normative feature, restricted and having as a goal to protect the environment (Millikan and Del Prette, 2000).

Silva and Santos (2004) argue that the zonings under various features that they might receive, converge in their results, which is the delimitation of areas, even though different methodological guidelines, varying according to the objective or to the object.

Therefore, the zoning cannot be seen only as a restriction tool, but as a social regulating one of the social use of the natural resources. So, it must be seen as a land management model, based on the availability and transparency of information and on the social negotiation of the regulating goals of the appropriation and use of the territory.

At this point, one can make use of tools of geotechnologies for the execution of the Environmental Zoning. The geotechnologies take a relevant role in the environmental management for turning the managing of spatial data more didactic and intuitive, besides allowing different types of analysis, raising the critical power in the decision taking. They can be understood as one technology that integrates data contained in a plan of spatial data or georeferenced.

Its treatment and manipulation open a range to the elaboration of theme maps analysis somewhat simple, which establish correlations between the spatial representation and the available information.
Inserted in this context are the Geographic Information Systems – GIS, which, for RODRIGUES (1993), can be understood as a “collection set of technologies, processing, handling and presentation of spatial information”. Allied to GIS, is the GIS Data Base, which consists of a data collection interrelated and a program to provide the access to these data, according to MAZUR (2013). The correlation between the GIS and its Geographical Data Base can be understood as the Spatial Analysis in GIS, tool that allows various types of manipulation of spatial data in order to extract new knowledge as products.

After the conceptualization, it is worth to present the case study, since the developed research was motivated by a project demand for the establishing of a new railroad trace. The railroad Nova Iguaçu/RJ – Cariacica/ES, whose trace will be evaluated and possibly reconfigured for the its reactivation, is approximately 640 km long in an predominantly northeast – southwest alignment, and develops transposing the portion central-south of the state of Espírito Santo and the state of Rio de Janeiro, from the border to the north with the state of Espírito Santo, up to its central-south, ending in the “baixada fluminense” region, near the capital of the state of Rio de Janeiro.

For the development of the socio environmental zoning, which is the main goal of this research, was used as input public data basis namely: natural cavities, speleological potential, conservation units, priority areas for the biodiversity conservation, quilombo communities, indigenous lands and use and ground cover, this last one for identification of the Mata Atlântica remaining and definition of areas with anthropic use.

For the use of data and its insertion in a database, it was necessary the performing of pre-processing. They were: alteration of the DATUM and of the coordinate system developed, to standardization, avoiding positioning mistakes. It was also executed a data selection contained in the spatial area established for the developing of the research – states of Rio de Janeiro and Espírito Santo, in order to reduce the storage space, improving, at the same time the further processing, for the mass of worked data gets smaller. Besides, it was established the buffer zones of the Conservation Units (3 km), Indigenous Lands (5 km) and Quilombo
Communities (5 km) as instructed on Legislation. At last, it was attributed values to the socio environmental aspects identified in the official public basis divided in a scale of 1 to 5, based on the current environmental regulations, where 1 means lower risk aspects both to the environment and the enterprise, thus not needing trace deviation and 5 that means aspects of higher risk both to the environment and enterprise, thus needing trace deviation.

The data worked were this way classified: Unnecessary – No relevant socio environmental aspect was identified in the data used; Negotiable – Conservation Units of sustainable use, Quilombo Community Buffer Zones and Indigenous Lands; Unnecessary – with mapped aspects – Buffer Zone of Conservation Units of sustainable use and Priority Areas for the Biodiversity Conservation; Preferential – High occurrence potential of natural cavities and Mata Atlântica areas; Necessary – Conservation Units of full protection and Natural Cavities.

At first, the research was thought in the logic of the represented scene through maps and, in each scene, some weight variations were established, in order to make a comparison among them possible. Besides the differences in weights for their composition, three of the scenes were based on vector data and five of the scenes based on raster data. This differentiation also occurred so that there was a possibility of comparison of results among the formats of the input data models, in addition to the already mentioned weights.

For vector data the models were “Sum Models – Equal Intervals”, where the values were classified in equal intervals. The classifying through equal intervals divides the extension of values from the attributes in equalized subclasses. This allows the specification of the number of intervals, which, in this case, was of 5 intervals and so it is determined one break for each of them, based on the total extension of the attribute values.

Still, for the data in format vector, it was done the “Sum Model – classified in natural breaks”, in which, through an algorithm (Jenks algorithm), groupings are made naturally established among the values present in the attributes of the spatial data. The class breaks are defined by the best similarity in the composition
of a grouping for similar values and stress of differences among classes. The layers are divided in classes in which limits are established where there is a large relative difference in the data values.

The last model generated from the vector data, called “Weighted Model – with weight equitable attribution”, is the result of the attribution of weights to the values pre-established to each of the legal environmental restrictions used to compose the intended zoning. In the case study, were attributed the same weights to each of the variables or legal socio environmental restrictions.

As for the raster data, five maps were elaborated, through the application of two models: “Weighted Sum”, which after weight classification and attribution resulted in two maps with adoption of matrix 1 to 5 to 1, more suitable to the case in question, due to this same case present five classes of restrictions. Therefore, as application product of the methodologies cited, it can be appreciated 5 different maps, having as subsidy for its elaboration the same input data of all the others.

The first scene for raster data was “Weight Sum Model – with weights equitable attribution”, was attributed weight 1 to all the legal socio environmental restrictions identified. This way, each of these restrictions was multiplied by the established weight, added and overlapped.

The second scene for raster data was the “Weighted Sum Model – with attribution of different weights to legal socio environmental restrictions” in which were attributed different weights in order to highlight some restrictions that, by experience, are more complex and require greater effort to be beaten, when there is possibility of negotiation.

The third scene, using as input raster data was “Weighted Average Model – with weight equitable attribution and adoption of restricted areas to pixels valued 5”, in which, for the execution of processing models in raster data is possible, differently from what happens with vector data, establish restricted areas, which independently from weights and values are not computed in the weighing. This is especially advantageous when it is known in advance that some aspects that
compose the spatial analysis are clear and objectively restricted, making rule the exclusion of these aspects in the weighted average equation.

The fourth scene elaborated from the raster data was “Weighted Average Model – with weight equitable attribution and adoption of restricted areas to pixels value 5, except the ones of the category Urban Areas/Anthropic Areas”, which is based on the same assumptions of the previous model, where the rule for pixels valued 5 is of restriction. The difference here is due to the exception to those categorized as Urban Areas/Anthropic Areas, considered so in the weighing as with the other categories and their respective values.

Lastly, the scene “Weight Average Model – with different weight attribution for legal socio environmental restrictions and adoption of restricted areas to pixels valued 5, except the one of the category Urban Areas/Anthropic Areas”, which is a little more complex than the others cited so far, because more than establishing restricted areas, excluding from such rule the Urban Areas/Anthropic Areas, still establishes different weights to each socio environmental aspect considered.

After the appreciation of the model result, it seems that in considering a more complexity in its construction, the zoning becomes quite limiting for the action in terms of the land use and occupation, pointing to the necessity for further adjustments in the weighting.

Henceforth, for the Study of Technical, Economic and Environmental Viability of the railroad tracing, it was defined as the most adequate model, so, the “Weighted Average with weight equitable attribution and adoption of restricted areas to pixels valued 5, except the ones of the category Urban Areas/Anthropic Areas”. This model was referred to a group of engineering designers, which in turn, performed adjustments to the projected tracing at first, without having taken into account the legal socio environmental variable of restriction of land use.

For purposes of comparison, the original tracing existing today, has an approximate length of 640 km, yet the proposed tracing considering only the engineering criteria is approximately 620 km long and, finally, the proposed
tracing after the applying the defined model as the most adequate is approximately 670 km long.

The tracing, considering the legal socio environmental restrictions is, this way, the longest. However it is the one which presents the smallest chance of finding some limitation to the project. This way, the entrepreneur is able to assess which will be more advantageous for the intended work.

**Keywords**

GIS; Environmental Planning; Environmental Zoning.