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IMPORTANCE OF UP TO DATE POWER LINES' ENVIRONMENTAL IMPACT ASSESSMENT

Abstract: When environmental impact assessments are in question subjective approach is rather often applied. Regarding power lines, their proximity to inhabitations adds to the sensitivity of placement, since people in general are familiar with their local environment and value it. Due to time constraint impact assessment is too often done only from the legislative demands' point of view. Consequently the proposed solution can be rejected. To avoid such an outcome analytic informatics' tools were applied to upgrade the process of environmental impact assessment.

The existing knowledge on power lines' environmental impact was joined with data on important environmental values which are to be considered at maximum extent. All basic environmental protection principles, arising from protection, sustainability and preservation are incorporated into the methodology. The proposed approach enables and ensures also the incorporation of the civil initiatives' point of view regarding sustainable space management.

It has been proven on a number of cases that the proposed approach objectively ensures achievement of good conditions for human health, well being, quality of life and biodiversity preservation. As such it represents foundation in the environmental compliance assessment process. The proposed approach was successfully applied on the number of cases when power lines' environmental assessment was carried out.

The models' results – its advantages in different stages of the process within the environmental impact assessment – are presented in the article through real case studies. In the first case an overhead power line's feasibility assessment according to proposed sustainability recommendations for planners and investors is presented, as basis for consensus achievement among all parties. The second case is a case of new cable line placement in a densely populated area with surroundings recognised as highly protected nature reserve. The third case is a typical case of environmental impact assessment in which the model was used to enhance public communication, since general public strongly contradicts the proposed solution.

Key words: *dialogue, sustainable development, environmental protection, power lines, sensitivity model*

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1. ENVIRONMENT

“The survival factor”

Work or working activity represents an important factor in human survival. In basic definition work is a process of managed and rationally directed exchange of matter between human beings and nature. The process is done via biochemical reactions, in which basal metabolism is the source of energy, derived from two fuel sources – glucose from food and ketenes from body fats. It is quite obvious, that such body work no longer fulfils the demands of a modern human being and its society. Consequently, other forms of work have evolved through history. From the beginning the advantage was taken from the body work of other human beings, but gradually it was transferred to human directed machine work.

In the industrialization era an important share of energy for mechanic work was provided by the fossil fuels. With an increase in quantities used, questions regarding safety hazards were raised. In 1905 dr. H. A. De Voeux presented an article titled “Fog and Smoke”. The article introduces the existence of smoggy fog which forms in the cities, but is absent in countryside. The same author in 1911 presented a report on the autumn of 1909 cases in Edinburg and Glasgow, when more than 1.000 people died due to air pollution causes. The named reports represent the beginning of research on air pollution effects on human health, which later evolved into environmental protection as basic activity to ensure human health in the increasingly industrialized society.

Environmental protection does not radically prohibit all activities which are potential pollution sources and can in turn influence human health. On the contrary, rational scientific approach led us to understand the environment as a closed and dynamic system in which quantity is invariable. Elements and energy cycle in biogeochemical cycles among its forms, and while cycling, a self cleaning capacity been established. The self cleaning capacity enables the environment to receive a certain amount of pollution products without having adverse effects on the ecosystems. Air can be treated as well, but the pollution load has to be known. Accumulation of large quantities of pollutants may exceed the environmental limit load, sensitive biogeochemical cycles are thus interrupted and severe disturbance arise in the environment. Today’s prognostic tools enable relatively good prediction of expected environmental impacts. Thorough knowledge on anthropogenic effects serves to prevent excessive pollution grade and conditions for wholesome ecosystem’s development can be preserved.

Environment itself is not important only from the self-cleaning capability point of view, but also from the natural resources point since without them there would not be any development and technological progress. As their availability is limited the society wanted to seize and use as many different resources as possible through history. When excessive use is present, many direct and indirect harmful effects follow. This is certainly the case in small stream barrage for hydropower water use. If all available and economically justified water had been used the ecological function of water environment would be lost. Empty river bed would in time with the

exception of extreme meteorological conditions be overgrown as a dry habitat. But floods would damage the dams and water stream would eventually return into its primary state.

Environment itself is a source which enables life and development but only when sensibly reasonably used. Environmental protection thus includes a scope of activities of nature preservation and its protection against pollution, irrational exploitation and other human interactions. The society in general has accepted principles of sustainable development since contrariness to environmental protection sooner or later causes problems and developmental drawbacks. Natural resources' overuse limitation and rational use fostering is an important yet remaining task in the pursuit of a bright future for the humankind.

Nowadays society's actions and activities which will provide for the same or better life quality also to future generations are those in accordance with sustainable development principles. Balance between economic prosperity, social justice and healthy environment is fundamentally important. The core of solution leading to success is in synergy of all three goals. Politics, which acts in favour of environmental preservation, stimulates innovativeness and competitiveness which in turn encourages economic growth is essential for social goals' achievement. On the global scale this indicates protection of Earths' capabilities to maintain life in all its diversity and respect the natural resources limitations.

2. ENVIRONMENTAL LAW

"Global answers and local commitments"

The role of environment and its capability to absorb the influences of our activities has to represent the foundation of a common social agreement. Since the beginning of history people have been veering towards comfortable life also on account of another's work. Development in the technology field enabled exponential progress. Progress was followed by irrational natural resources exploitation which raised the need to implement protection mechanisms. The society reached a stage in which absence of legal regulations framework represents a threat to humankind and the rest of nature.

The Stockholm declaration, adopted in 1972 represents the first milestone in environmental protection in the history of our civilisation. The conference sent the first serious message to society to alter the prospect in general and to acknowledge the consequences of disharmony between men and nature.

The following milestones represent important institutional steps in the environmental protection field:

The Stockholm declaration of United Nations conference on human environment from 1972, the World Charter for Nature declaration from United Nations General Assembly from 1982, Declaration on environment and development of United Nations conference in Rio from 1992 with Agenda 21 as a resolution document, international treaty from 1997 titled Kyoto protocol and Aarhus convention from 1998.

The goal of up to-date environmental law is to form an integral approach rules' system towards the other biotic communities. The integration of environmental protection rules into constitution as the highest legal act represents a key step in this regard. Sustainable development is integrated into up to-date constitutions through the following contents:

- Healthy environment preservation as a state responsibility.
- Ecological function of property.
- Right to healthy living environment.



Figure 1: Normative system of environmental protection

3. IMPACT ASSESSMENT

“Control over societies’ sustainable development “

3. 1. SPACE

Normative contents’ definition represents the foundation for states’ or communities’ environmental law formation. The primary intention of normatively set environmental protection is to stimulate and direct social development which in the long term establishes conditions to assure human health, well being and quality of life as well as biodiversity preservation.

However, also politics is one of the determining forces of progress and people, despite legal mechanisms of environmental protection often don’t respect natural resources’ limitations. Albeit understood as general welfare the environment can easily be overlooked and many times only good fortune prevents the worst consequences of reckless behaviour. Basic knowledge of environmental law is thus necessary to ensure healthy living environment.

Environmental politics is based on belief that economic growth, social advancement and environmental protection all contribute to increase in life quality. There are a number of regulations which bind society to fulfil the obligations regarding healthy environment preservation, property's ecological function and everyone's right to healthy environment. Subsequently, sustenance of reciprocity is a maximum when environmental regulations are in question.

Space as one of the environmental resources has always represented an important strategic base in evolutionary terms, since the expansion on freely disposed territory strengthened civilizations, nations, republics, unions influence and power throughout the entire history of mankind. It appears that the awareness of space management importance is written in the human genome, since the necessary space disposal ensures the survival possibility. Due to population density and technological progress the space management based merely on the territory increase was, at least ostensibly replaced by management of limited space available. Such an approach requires complete awareness of space as a non-renewable source.

One of the functions of space as a source is directly related to land use and describes the state of the landscape and soil management. Management results from natural resources, historical circumstances, socio-economic development and spatial planning. According to land use the space is divided to urbanized areas, industrial zones, agricultural land, forests, variously preserved natural areas, wetlands and water surfaces.

The loss of land surface has an impact on its economic as well as ecological role. The loss of agricultural and forest land is most often induced by urbanisation. Its devastating impact on lands' environmental and economic role is irreversible. Change in land use is most noticeable in road network extensions. The overhead power lines change forests into scrub forest areas or overgrown areas. Permanent changes of the best agricultural land and urban land use expansion on the bottom of valleys qualify as the most negative impacts on surface.

Space has at the same time an intrinsic as well as economic value; therefore land use must be extremely carefully planned. Role of comprehensive spatial planning strengthened in the 1960 s, when awareness of the need of environment protection in developed society's consciousness increased. It is more reasonable to perceive the landscape as cultural heritage that must be managed rather than a living organism that evolves under the influence of dynamic forces of nature and social processes (*Marušič, 1998*).

The aim of the quality spatial planning is to avoid or resolve conflicts in space by targeted regulations and spatial planning guidelines, which include:

- creating and providing spatial conditions which enable coherent social and cultural development of an individual or a group,
- natural environment preservation, preservation of natural resources, cultural values and the overall environmental quality,
- balanced development and preservation needs,
- sustainable development with emphasis on space characteristics' preservation for current and future generations,

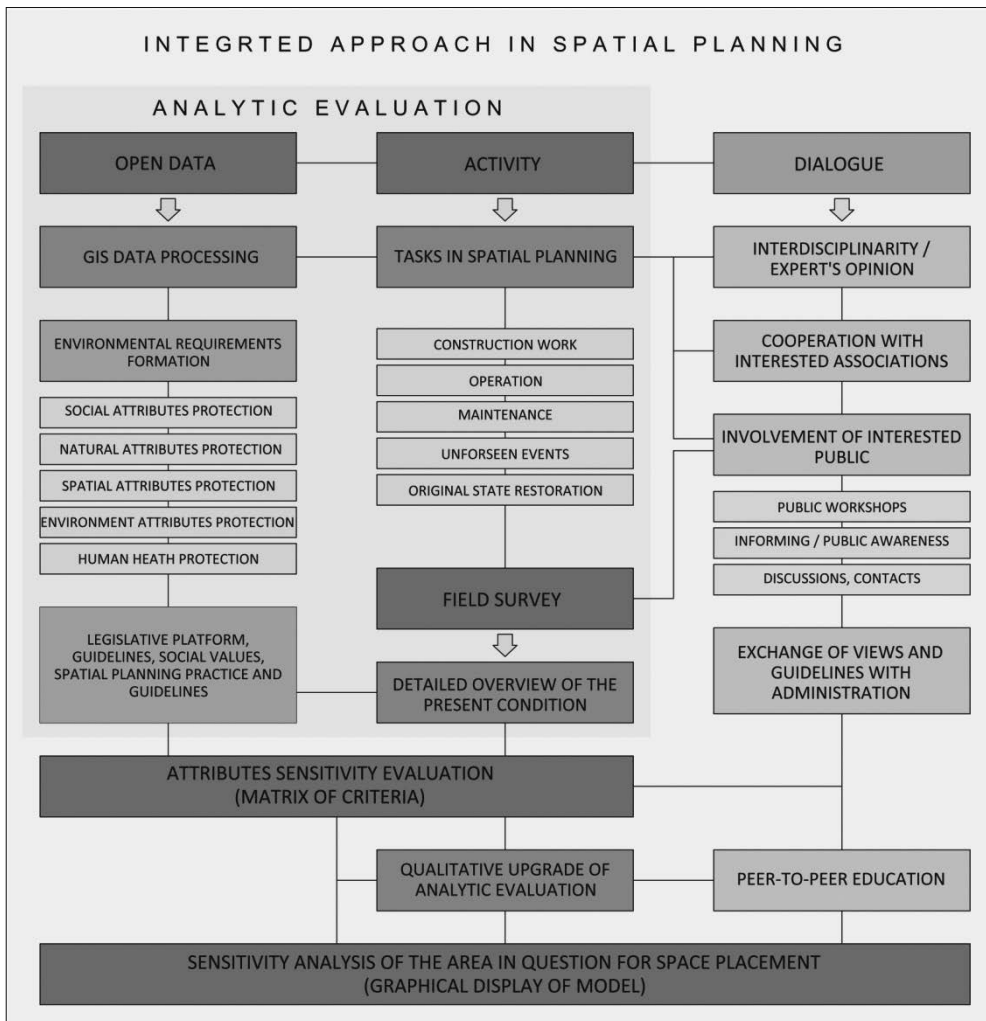


Figure 2: Course of the integrated approach to placing activities in spatial planning

- quality and equivalent living and working conditions in different areas,
- spatially coherent and mutually complementary distribution of the various activities in space,
- maintenance and development of spatial diversity and quality spatial structures.

Before an activity is implemented it is of utmost importance to thoroughly examine all possible factors which may affect space quality. Thorough field investigation to identify space' intrinsic and economic value is necessary, since every activity has a unique spatial aspect. Thus a broader picture of the activity's complexity in terms of spatial planning in a specific environment is obtained.

In spatial planning process the environmental protection role is important since it has the equivalent importance as spatial, functional or economic aspect. The following diagram shows the content and course of an integrated approach to placing activities in spatial planning.

Spatial plans' implementation in protected areas is particularly sensitive. In protected areas the environmental impact assessment process and planned activities' acceptability evaluation are longer and more challenging, since a separate environmental impact assessment is necessary. Through the assessment compliance with the areas' protection objectives and its integration and interrelation preserving are being identified and evaluated. The direct, indirect and cumulative impacts must be considered.

3. 2. ENVIRONMENTAL PROTECTION

If sustainable and balanced spatial development is to be followed, concepts of planning, protection, preservation and development have to be considered as equally important activities if all different attributes' values are to be preserved. Space is the most important attribute for the people who live in it for generations and only an integral approach to spatial planning can ensure its social acceptance.

When principles of environmental protection are respected in the spatial planning procedure the environmental quality, natures' values and natural and economic resources preservation is ensured. The impact is acceptable up to the environmental load limit until there are no direct adverse effects onto the single environmental attributes.

Environmental components which are sorted into theme groups based on environmental requirements represent important elements to determine overall environmental impact. Attributes are divided into the following theme groups: spatial, environmental, natural, social and health protection attributes. They are represented in Table 1.

Environmental components aren't sensitive inherently but only after an impact resulting from activity or interference is introduced. Thus impacts' definition starts with important impacts' recognition determined by the nature of activity being spatially placed. Above all the safety, environmental impact, technical feasibility, the feasibility to construct and economical aspect are considered.

Sustainability and environmental protection principles are included into the planning procedures. Environments' and natures' sensitivity is determined by environmental report as part of the spatial plan. It can be concluded that maximum yield in decreasing or minimising adverse environmental impacts can be reached when a procedure is carefully planned and environmental demands are taken into account in the early phases of spatial planning (*Cof et. al, 2005*).

Environmental components' analysis which is part of the environmental impact assessment process is based on publically accessible data on demanded protection regimes in particular areas being assessed. Protection regimes are implemented with regard to these areas in which activities are feasible only when particular

Table 1: Environmental attributes and impact on spatial quality indicators

ATTRIBUTES	COMPONENTS	POTENCIAL IMPACTS
SOCIAL ATTRIBUTES	Residential environment	inhabitation potential, impact on existing inhabitation
	Economic activities	economic development, loss of income, the number of employees
	Social value	tourism, recreation and free time
	Cultural heritage	culture
NATURAL ATTRIBUTES	Natural resources and natural areas	adverse effects on sensitive natural areas and ecosystems
SPATIAL ATTRIBUTES	Geomorphology	terrain stability
	Ground floor	temporary or long term loss of land, floor area and spatial use
	Landscape	visual impact on landscape and environment
ENVIRONMENTAL ATTRIBUTES	Soil	soil contamination, soil modification
	Water	running water and underground water quality
	Air and climate conditions	air quality
HEALTH PROTECTION	Noise	human health impact
	Electromagnetic radiation	
	Light pollution	
	Drinking water	

rules are obeyed. Rules are defined by demands, directives and limitations in the frame of local and governmental legislation.

A prima facie the most sensitive areas are best to be avoided but it has to be kept in mind that according to the law there are 15 components which have to be considered, each of them having its own set of protection regulations. This is not to say that activities in sensitive areas are not possible, on the contrary, the goal of all environmental regulations is not limitation but suggestion in the process of defining optimal solutions. Experts have created guidelines which are to be considered when activities in the sensitive areas are planned.

In the environmental impact assessment procedure all the spatial planning factors have to be addresses comprehensively and equally and at the same time also all environmental components have to be equally and coherently addressed. A certain activity can have diverse impacts on particular environmental component which are reciprocally dependent. Such a method assures the impacts on environmental components are objectively defined and adequately assessed and evaluated.

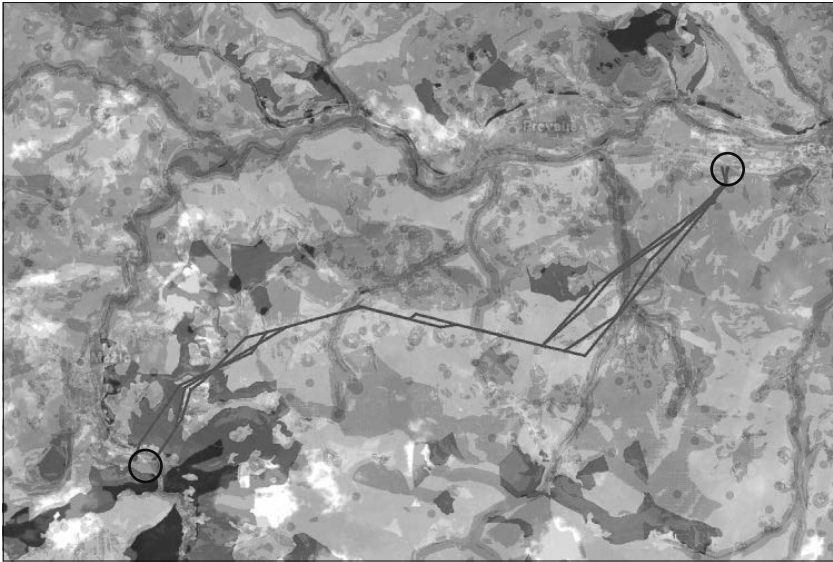


Figure 3: Environments' sensitivity synthesis for overhead power lines' installation and operation

Environmental sensitivity models result from equal treatment of all spatial planning factors through which suitable recognition of all values is enabled leading to objective and optimised spatial regulations.

In the Figure 3 a case of environmental impact assessment is given, presenting the very first considerations on new overhead power line construction (Bole *et. al*, 2013). Various possible limitations have to be regarded / studied before the actual administration process starts. A synthesized sensitivity model through which the overhead power line is to be placed is given in Figure 3. Darker marks indicate higher sensitivity of the area regarding installation and operation. Bars indicate various technically feasible variants of power line between two areas to be connected.

The model is composed of various spatial data which are part of geographical information systems, sensitivity analysis are performed by computing processes. Thus the following aspects can be relatively accurately addressed:

- least sensitive locations or areas for possible object placement,
- various possible solutions,
- optimisation possibilities in the spatial planning phase,
- foundation for environmental impact assessment (environmental studies, environmental report, environmental impact assessment).

Areas of higher sensitivity with overhead power lines' direct proximity were analytically assessed in detail by the help of exhaustive computing calculations, field work and public inclusion. Field work is necessary since it provides insight on space particularities as well as professional and laicly public's opinion; it qualitatively supplements the analytical evaluation.

In the named case we have, founded on the previously described approach which is based on sensitivity models and dialogue stimulation, reached consensus on spatial regulation acceptability among all parties (management authorities, expert's opinion, interested public, interest associations and investors).

3. 3. DIALOGUE

There is a difference in comprehension of value as worthiness on one hand and values on the other. A different relation towards fertile land was established in areas with large plots of fertile land and developed agriculture as opposed to areas with infertile land. Where land is used for agriculture it has a practical value and where land is scarcely used for agricultural purposes it represents more an intrinsic value. Only when a source is scarce people acknowledge its actual role and importance for survival and development.

Social admittance of proposed strategic objects construction which strengthens and consolidates economic and political power of the state is easily replaced by social unacceptability. Practical cases show that disregard towards general opinion prolongs administrative procedures, breaches deadlines for construction work conclusion also for objects important in the state level; sometimes the procedure can even be suspended indefinitely.

Today's role and importance of environmental report has to be widened if a consensus is to be reached among all parties' interests. The environmental report preparation procedure has to stimulate dialogue among experts from different fields of expertise, needed for project implementation. The matter of fact, a consensus can only be reached if an interdisciplinary approach is applied which includes all aspects of a project: spatial, technical, constructional, environmental and economic. It is also necessary to include key concerns, suggestions and demands of the interested public.

At all investments with environmental impact it is of key importance that the dialogue is based on correctness, reality and sincerity. Sincerity and ethical standards are compulsory for all key contractors. Any form of manipulation in the shape of misleading public image of the project does not contribute to higher environmental impacts' acceptability. They remain intrinsically sensitive. It is a fact that environmental problems are from the standing point of those inflicted never routine ones, but always unique (*Kos, 2002*).

Equal treatment of all contents with clear emphasis on mutual interactions is fundamentally important due to various parties included into the process of line infrastructure space planning procedure. By means of proposed approach criteria a legitimate environmental problems' settling can be met which acts as basis for interactive communication (*Kos, 2002*). This kind of dialogue gives an active role to all interested groups and serves to prevent subjective risk perception with unaffected and idle parties since they can slow down or even impede and stop the spatial planning.

If general people are unfamiliar with functioning and effects of technology, consequently they rely on intuitive risk judgements, called risk perceptions (*Lopez – Rodriguez, 2013*). Thus perceived risk closely resembles psychological uncertainty and can be defined as a subjective assessment of probability of an accident happening and degree of concern about its consequences. Subjective perception of accident probability and its possible consequences concern and leads into opposition to technology. Technology opposition and demand for risk mitigation are often based more on risk people perceive to be real, rather than the one really existing.

Today's' expert and laic public's role is increasingly important in environmental decision making, since it has an institutional role. Consistent respect of environmental protection aims does not suffice. This role was given to the public by Aarhus convention, an international treaty attributing individuals or groups an important role in environmental preservation and sustainable development enforcement. Aarhus convention determines basic principles of public cooperation among which the following are the most important:

- public inclusion in early stages of the decision making, when all possibilities are opened,
- corresponding time intervals are to be respected to allow public inclusion in particular phases of the procedure,
- contribution of public meetings is appropriately considered and decisions are justified.

By Aarhus convention ratification the state is bound to reach social consensus in all questions regarding environmental protection and to include all parties into the process (administration, experts, interested public, interest societies and investor) (*Milković, 2002*). Parties have to have free access to environmental information, possibility of public participation in decision making and access to justice. In other words this means that subjective risk perception in spatial planning has to be taken into account and this kind of risks have to be suitably incorporated into integrated environmental impact assessment methodology.

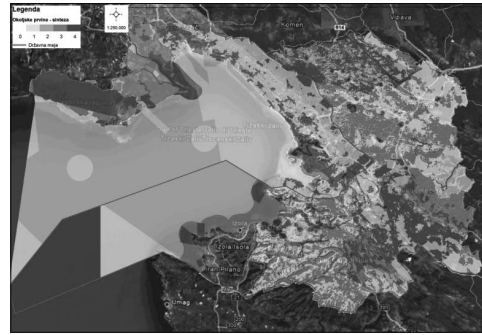
3. 4. POWER LINES

In the past electrification brought about comfort, based on efficient utilization of mechanical work. Today, electric power represents the main energy carrier from renewable sources, which in turn represent the foundation for sustainable development. Its role in environmental protection is thus increased.

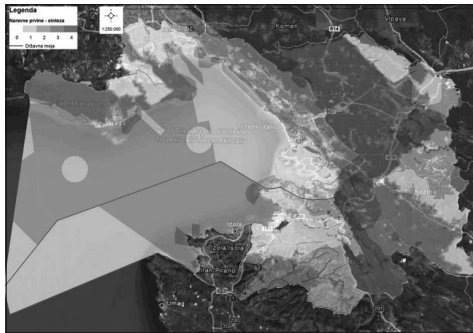
Access to electric power is taken for granted in nowadays society, thus other values are becoming increasingly important. People refuse to renounce to space quality on account of comfort since they believe both aspects can be met. This is also to be attributed to electric power systems' robustness which was improved through the years. Consequently the electro-technical profession has to make an effort towards understanding the environmental impact assessment procedure and finding equilibrium among involved parties. On the other hand also power supply's reliability has to be maintained to meet the needs of modern life (*Soini et al., 2010*).



a) spatial attributes



b) environmental attributes



c) natural attributes



d) social attributes

Figure 4: Environmental attributes analysis in the Gulf of Trieste area

Overhead power lines are classified as technical infrastructural line objects. Safety corridors of different width are established around them. In the safety corridors not only basic spatial planning principles but also specific rules apply which are implemented to assure minimal safety demands for overhead power line operation. As a rule, overhead power lines' safety corridors aren't fenced nevertheless these objects have to be understood as technically complex objects for energy transfer purposes.

When overhead power lines are compared to motorways and high speed rail track, there is an obvious difference in physical land occupation. With the last two, the original land use in safety corridors is made impossible. Consequently compensations have to reach the full value of real estate used by the infrastructure. When overhead power lines are in question, land use is the least limited and special safety precautions apply only for physical approach to conductors. In matter of fact in the past, safety corridors were not evident in spatial plans. This resulted in absence of foundation to limit free disposal of property as well as any compensation demands due to limited property rights. When it is understood that in the past no limited

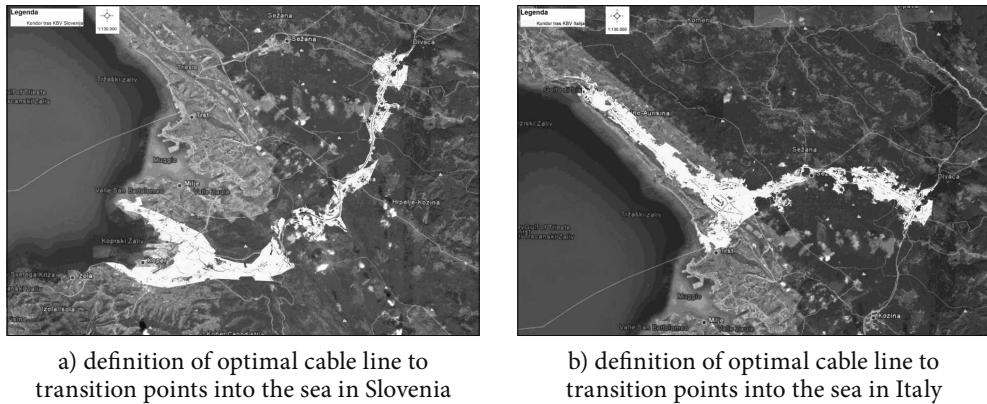


Figure 5: Optimal cable line placement definition between the littoral and Karst area

property rights compensation model has been applied, it can easily be understood where a reasonable amount of opposition towards overhead power lines comes from.

Protection against electromagnetic radiation was included into environmental protection at the end of the last century. Electromagnetic radiation later indicated measure to define the overhead power lines' safety corridor width. When measure was defined, it also established foundation for the limited property rights compensation model or factual servitude application. It should be emphasized that electromagnetic radiation limitations were applied only on land use for inhabitation, while agricultural land compensation measures remained unchanged.

The next case explains guidelines' implementation for new cable line placement in a densely populated area with intensely protected natural values in the hinterland (Vončina *et al.*, 2012). Equivalent criteria were used for Italy as well as Slovenia to perform sensitivity analysis for the Gulf of Trieste area. The method applied revealed also differences in particular sensitivity definition since different criteria are applied by both states and their local communities. In Slovenia the preservation of natural attributes in the littoral and Karst area is characteristic, while in Italy the river Soča delta and Gradež lagoon represent important natural values. The last one represents also an important social attribute due to area's landscape characteristics. In the Figure 4 values according to particular attributes are shown. The darker colouring indicates a more important value.

A computer assisted calculation was performed based on all available data on protection regimes, and cable line feasibility consideration. It resulted in cable line placement suggestion in both states which would cause least impact at sea – land passage and forward inland towards the starting point in Karst. The presented approach allows placement suggestion which is not subjected to partial decisions of spatial planners, engineers, environmentalists or environmental impact assessors (Figure 5).



Figure 6: Critical areas determined by the model and publicly exposed critical areas

The mentioned analyses were used in negotiations between both states' representatives. The agreement on concrete cable line placement was reached on the concluding meeting in which advantages and disadvantages of particular variants of sea – land passage were discussed from the technical and operational point of view. All argumentation between sides on eventual environmental and nature protection limitations and attractiveness of land – sea passage placement in the other, neighbouring country were unnecessary due to model results.

In the last case a classical environmental impact assessment model was used to support public dialogue with public who strongly opposed the proposed solution and investors who presented it.

Model determined as well as publicly exposed critical areas are marked in Figure 6. The interested public contributed critical areas in gatherings organised by municipalities in local communities in which the power line is suggested to be placed. It is clearly seen that model determined critical areas overlap with people determined ones. Whether the measures used to determine impact on health were suitable remains an opened questions. Until this question remains unanswered, intensified pressure and demands on further and stronger inclusion of interested public regarding decision making can be expected, which is in accordance with the principles of Aarhus convention.

CONCLUSION

When environmental impact assessment is in question a subjective approach is rather often applied. Regarding power lines, their proximity to inhabitations adds to the sensitivity of placement, since people in general are familiar with their local environment and value it. Due to time constraint impact assessment is too often

done only from the legislative demands' point of view. Consequently the proposed solution can be rejected. To avoid such an outcome analytic informatics' tools were applied to upgrade the process of environmental impact assessment.

The importance of rational use of natural resources is often forgotten in the prosperity of modern life. With abundance of resources still at hand it is hard to wholly grasp their importance to allow modern life. Besides their importance for the humankind the consciousness of resource quantity and its limitation, arising from the assumption that matter exists in a limited amount is of key importance.

Experts are those who do or should fully grasp the importance of rational resource use and prioritise equal treatment of space attributes within infrastructure spatial planning procedure. Only experts can, based on knowledge and interdisciplinary approach authentically present to the decision makers the actual value of space and prevent the unwanted consequences like degradation or property rights breach. It has to be kept in mind that natural resources have economic value as well as intrinsic value which arises from their uniqueness and has to be treated prudently. When priceless values are managed, all available knowledge has to be used and all decisions have to be accepted legally as well as legitimately and in no segment biased or gainful. It should not be allowed for the term environmental preservation to become a paradigm through which natural resources would be grasped as values only when their value would increase due to shortage.

Environmental sensitivity models result from comprehensive and equivalent consideration of all spatial planning factors. They allow suitable value consideration and spatial planning optimization. The fields of analytical sensitivity evaluation, field work, knowledge on investments' technical features, transparent process of publically accessible data and objective evaluation of environmental impacts are interacted in a computer model.

Sincere thinking and ethnicity are virtues through which the importance of dialogue in conflict situations, which in spatial planning can't always be avoided, can be more easily understood. It is important to comprehend respect and understanding of the opposite opinion of all parties in the process as a challenge to be faced with a lot of empathy for the different standing points. Compromise solutions can only be reached through dialogue. By the proposed way sustainable development principles and principles of consistent spatial planning, environmental protection and public collaboration can be followed.

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