Sustainability and aggregates: selected (European) issues and cases

Trajnostni razvoj in mineralne surovine za gradbeništvo: izbrana (evropska) vprašanja in primeri prakse

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Abstract: Sustainable aggregate resource management (SARM) is based on three pillars of sustainability: environmental, economic and social. The main environmental aspect is preventing or minimizing negative impacts by following these principles: precautionary principle, polluters' pay, and eco-efficiency. Economic aspects are (a) maintaining a viable business environment; (b) encouraging value-added production and employment; (c) embracing full-cost accounting while remaining competitive, and (d) providing for the material requirements of society. Social aspects incorporate: (a) identifying stakeholders' values, interests, goals, furthermore (b) transparency, (c) public participation in decision making, (d) communication and education. In order to provide information, indicators of sustainability for minerals of the European Union and indicators for aggregates for selected countries, including Slovenia are presented.

Povzetek: V članku obravnavamo gospodarjenje z mineralnimi surovinami za gradbeništvo po načelih trajnostnega razvoja, pri čemer so upoštevani okoljski, gospodarski ter družbeni vidiki. Okoljski vidik upošteva preprečevanje oziroma zmanjševanje negativnih vplivov na okolje, pri čemer upošteva načela: previdnosti, onesnaževalec plača ter eko-učinkovitost. Ekonomski vidiki so: ohranjanje gospodarske dejavnosti, povečevanje dodane vrednosti in zaposlenosti, upoštevanje vseh stroškov proizvodnje ter ohranjanje materialne osnove za blaginjo družbe. Družbeni vidiki upoštevajo vrednote in interese udeležene javnosti, transparentnost, sodelovanje javnosti pri odločanju, komunikacijo in izobraževanje. Poleg

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tega obravnavamo tudi kazalce gospodarjenja z mineralnimi surovinami glede na vse tri vidike trajnostnega razvoja, in sicer na nivoju Evropske unije ter posameznih držav, vključno Slovenije.

Key words: aggregates, sustainable development, management, Europe
Ključne besede: mineralne surovine za gradbeništvo, trajnostni razvoj, gospodarjenje, Evropa

INTRODUCTION

Many of the social and environmental problems we face today are complex, urgent, and interconnected across systems. The partial, system-specific solutions used in the past have proven ineffective when applied in such circumstances. The Earth Summit held in Rio de Janeiro in 1992 brought the concept of sustainable development to the attention of the world. The sustainability paradigm is applicable to the types of problems mentioned above because it is both comprehensive and flexible. The overarching goals of sustainability are: economic prosperity, environmental health and social equity. These goals are simple and flexible enough to allow for multiple interpretations and are applicable in a variety of circumstances (ŠOLAR, 2003a).

They are, for example, applicable to mining. The purpose of mining is the extraction and processing of mineral resources. These resources are almost entirely nonrenewable; an individual deposit cannot be recreated except through natural geological processes. Nonetheless, over the past ten years, public discourse on the compatibility of mining and sustainability has progressed from disbelief and rejection, to scepticism, to general acceptance. The basic reason is recognition of the fact that mineral resources are both essential and can be provided in a way that protects the environment and respects the needs and rights of communities. Doing so, however, will require policies that promote and support sustainable behaviors and outcomes.

Policies reflect the values and objectives of the people involved in their creation. That is as true for mineral policies as it is for environmental, monetary or trade policies. According to most general definitions, management deals with the process of planning, organizing, and governing the efforts of co-workers in order to achieve stated goals of an institution. Management therefore about is optimizing the use of human and material resources, together with financial and other contributions, to operationalize policies. The objectives of a sustainable mineral resource policy and associated management plan, and the form they take, will differ between regions and countries due to the interplay of differing value sets, goals and objectives (LANGER et al., 2003).

Differences not withstanding, there are similarities across sustainable mineral policies and management plans. The foundational concepts are: a) facilitating the transformation of natural mineral capital into built physical, economic, environmental or social capital of equal or greater value; b) ensuring that environmental and social impacts of mining are minimized; c) addressing the trade offs that society needs to make, and d) taking all relevant scale hierarchies into consideration.

Aggregate Resources

Mineral resources are classified in many ways. Most commonly they are classified into non-metals, metals and (solid or fluid) energy resources. Non-metals consist of two major groups: industrial minerals, and construction materials. Within the construction materials group aggregates (crushed stone, sand and gravel) are prevailing over others (such as clay, dimension stone, etc.) in terms of volume produced.

Natural aggregate consists of material composed of rock fragments that may be used in their natural state or after mechanical processing such as crushing, washing, and sizing. Natural aggregate consists of gravel and crushed stone. Gravel generally is considered to be material whose particles are about 2.0 to 64.0 millimeters in diameter. Its edges tend to be rounded due to the effects of repeated contact among particles. Crushed stone is of the same size range, but is artificially crushed rock, boulders, or large cobbles. Most or all of its surfaces are produced by crushing, which results in sharp and angular edges. Natural aggregate has hundreds of uses, from chicken grit to the granules on roofing shingles. However, most aggregate is used in concrete, asphalt, and for other construction purposes (Langer & Šolar, 2002).

Natural aggregate extraction is the most important mining industry in the world in terms of production volume (15,000 million tones per annum), and is second only to fossil fuels in terms of production value (70,060 million euros) (Regueiro et al., 2002). The average per capita consumption of aggregate generally ranges from 5 to 15 tons per year (Langer & Šolar, 2002). More than 3 billion tones of sand, gravel and crushed stone are produced annually to meet the demands of the European building and construction industries. Assessment of the actual quantities of construction minerals produced in Europe is difficult because some of the national statistics that are being provided to the European Statistical Office are based on a representative survey of the aggregates sector, which means that not all small and very small quarries are covered by the European statistics.

Aggregate is heavy and bulky. Transportation can add significantly to the cost of aggregate. For example, transporting aggregate 30 to 50 kilometers can double its price. As a result, aggregates have historically had a narrow economic transportation radius, which has led to the presence of extraction near urban areas. While most of the construction minerals continue to be produced close to the major development centers, the establishment of mega-quarries next to the sea in Norway and in Great Britain is a new development that could have important consequences for parts of Europe which can be reached by bulk carriers.

Developing aggregate resources impacts the environment. Most environmental impacts are not serious and can be controlled by employing careful mining practices (environmentally friendly and economically efficient) using available technology. However, there are some geologic situations where mining aggregate may lead to serious environmental impacts, especially with regard to ground water, air, and noise pollution. Environments that are particularly prone to impacts from aggregate extraction include karst and stream channels. One of the most serious environmental problems is the dereliction of abandoned pits or quarries. The reclamation of mined-out land is an important aspect of reducing environmental impacts of aggregate extraction.

In regions with economic growth, the negative public perception of quarrying increases in tandem with demand for aggregates. Operators face serious difficulties in opening new, or maintaining current, quarries or pits. More generally, societies face several dilemmas with regard to aggregate resource management: a) the existence of abundant sites with suitable aggregate that also have conflicting land uses, zoning, regulations, or citizen opposition, and b) conflict between regional demand and local opposition to resource extraction.

Aggregates should be managed similarly as other earth resources / minerals taking into account their specifics (described below).

Sustainable Aggregate Resource Management

A sustainable aggregate resource management (SARM) plan can be organized according to the three main dimensions of sustainability: environmental, economic and social (Šolar et al., 2004).

Environmental aspects of SARM

SARM requires developing aggregate resources in an environmentally responsible manner that does not result in long-term environmental harm, even if short-term environmental impacts are unavoidable. Two main environmental categories should be considered in SARM: reducing negative environmental impacts and resource protection / conservation. These goals are very achievable because the aggregate industry has made, and continues to make, great strides in environmental management.

Three principles inform the forgoing requirements: the precautionary principle, the polluter pays principle, and eco-efficiency. The meaning of the precautionary principle has evolved since its introduction in the 1970's. Initially it stated that actions to protect the environment should not be delayed simply because full information was unavailable. This is the meaning used in the Rio Declaration, which states that the lack of "full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation"(UN, 1992). The obverse definition is now dominant. We should not take actions in the absence of full information, if those actions have a high probably of causing social, economic, or environmental impacts (Foster et al., 2000). Both versions apply to quarrying. The precautionary principle implies the use of environmental impacts assessments, risk analysis and other tools so as to promote the goal of nature conservation.

The polluter pays principle requires funding reclamation / remediation of negative impacts within the quarry and over the mine life cycle including after-care. Eco-efficiency is achieved through the implementation of efficient production practices (with minimal material and energy use and emissions), efficient use of land / space, and the full exploitation of reserves and resources.

Most destructive environmental impacts of aggregates are on the landscape (visual intrusions), air (noise, dust), water (surface, underground water), soil (erosion, pollution), and on biota (loss of biodiversity). Besides type, the nature of impacts (range, timing, duration, ability to prevent /control) should also be considered (Langer & Arbogast, 2002). There are many regulatory and voluntary tools that can be used to identify, reduce and control negative environmental impacts. These include environmental impact assessment, environmental management systems, environmental accounting, environmental reporting, life cycle analysis, ISO 14000 standards. These tools can be applied both on-site (quarry & processing facility) and to transportation routes.

SARM, however, is not just about protecting the environment from the potential negative impacts of aggregate extraction. Reclaiming aggregate operations or orphaned sites has tremendous potential to improve our quality of life, create additional wealth, increase biodiversity, and restore the environment. In the expanding suburban areas of today, mined-out aggregate pits and quarries are converted into second uses that range from home sites to wildlife refuges, from golf courses to watercourses, and from botanical gardens to natural wetlands. Reclamation should be a major consideration in sustaining the environment and in creating biodiversity (Langer, 2003a).

Mineral resource (aggregate) protection includes: a) minimal exploitation of primary aggregates with rational production by introducing the recycling and reuse of construction materials as aggregates; b) exploitation of renewable aggregate and substitute resources; c) increasing the knowledge about aggregate potential, and d) preserving the land access to aggregates in designated areas. The first two of these protection measures are intended to reduce the demand for aggregate that is newly mined or from newly developed sites. The latter two address the long-term need for primary materials (Šolar, 2003).

<u>Economic aspects of SARM</u>

There are four main economic aspects to SARM: a) maintaining a viable business environment; b) encouraging value-added production and employment; c) embracing full-cost accounting while remaining competitive, and d) providing for the material requirements of society. The first two of these are the responsibility of government. The third is the responsibility of the firm. And the fourth is a shared responsibility of government and the firm.

All societies utilize a stream of material inputs for manufacturing and construction. In the case of transition and post-conflict economies, there is particular need for construction materials to support development and rebuilding of infrastructure, industrial capacity, and housing. One aspect of SARM involves ensuring that these resources are available to the marketplace. This is sometimes referred to as secure supply. The main elements of secure supply are creation or maintenance of production capacity, identification of sufficient reserves and resources, provision of land access (extraction and exploration sites / areas), and development of the country's or region's infrastructure capacity (roads, railroads, power). All the foregoing issues are interlinked and need to be balanced by policy makers and resource managers.

A viable business environment exhibits the following characteristics: a) a stable and feasible permitting regime; b) consistent application of rules and regulations; c) functioning capital markets; d) reasonable levels of taxation, and e) well-defined property rights. Under employment and unemployment are serious problems in many parts of the world. Therefore, governments should also consider setting policies that support the availability of a trained workforce and promote employment in the extractive industries. Development of value-added manufacturing is another important issue. Existence of a value-added sector can reduce the need for imported materials while allowing the domestic economy to capture economic benefits (profits, employment, tax revenues) that would otherwise accrue in another country.

Economic realities drive industry activity. Firms need to remain competitive if they are to stay in business. Nonetheless, firms have a responsibility to accept the full cost of doing business, including costs of preventing or remediating environmental damage. Industry must be willing to accept the fact that in some cases, when all the costs are taken into consideration, a quarry will not be a viable economic enterprise and must be either shut down or not developed. Firms can, however, increase competitiveness by modifying production processes, upgrading product quality, and maintaining a well trained workforce. Production process and product quality can be achieved through voluntary quality control procedures such as adherence to ISO 9000 requirements. Quality is an important market element that can be labeled and traded. Research and development (R&D) is another issue that increases the enterprise's overall performance and has a great impact on increasing the added value. Some of R&D's goals include new products, and using BAT (best available technology) in the field. Finally, maintaining or increasing employment is not only governmental issue, because human resources are one of most important driving forces of every enterprise. Corporate culture, knowledge and skills need to be created, maintained, reviewed and revised (if necessary). Special attention with regard to human resources should be put on health and safety of employees.

The issues described above, along with many others, represent the economic aspects of managing aggregates in a manner that would ensure future aggregate supplies and achieve the sustainability goals of different stakeholders. Their various and different goals and linkages among those interests and goals are described within social aspects of SARM (Šolar, 2003).

Social aspects of SARM

Identifying stakeholders' values, interests, goals and the scale at which they apply is the first step in resolving the complex situations that impact a country's ability to maintain a secure material supply and achieve other policy goals. As an example, there may be abundant sites in a region that have suitable aggregate, but the existence of conflicting land uses, zoning, regulations, or citizen opposition can lead to insufficient or more costly supply. Scale of interest is a consideration in such situations due to fact that benefits and costs accrue to different parties in different regions. A third important issue is intra-generational equity, fairness to those living near, or impacted by, quarrying. Equity implies a need for transparency and public participation in decision making, as well as access to information within democratic process (Šolar, 2003).

Broader societal aspects can be described in terms of the legal framework, communication and education. The legal framework should protect the interests not only of country or region, but also investors and all other stakeholders. An effective legal framework needs balance between administrative requirements and flexible, time efficient, inexpensive procedures of licensing. Further, a country or region needs to have the institutional capacity to implement and enforce the legislation (monitoring and control components in particular), to develop and maintain resource information infrastructure, to foster research and development, to use funds from mineral rents (taxes) for the benefit of current and future generations, and facilitate cooperation with other sectors.

In addition to the legal framework, voluntary initiatives from different stakeholders (industry, non-governmental organizations) enrich dialogue and facilitate agreements. Voluntary initiatives include communication, education, partnership, and participation. All stakeholders should have access because increase awareness of the costs and benefits of supplying materials to society will lead to more timely agreements about how to (re)distribute costs and benefits of aggregate extraction and use (Šolar, 2003).

Best practices

To be effective, SARM must be a pragmatic pursuit, not an ideological exercise. It is an iterative process and government, citizens, and industry should all be involved in the pursuit. The process consists of a number of steps, including issuance of policy statements, elaboration of objectives, establishment of actions, identification of indicators, and monitoring (Langer, 2003c).

- Policy statements issued by governments commonly identify the aggregate industry as a key industry contributing to jobs, wealth, and a high quality of life for its citizens, and commit the government to the protection of critical resources and protection of citizens from the unwanted impacts from aggregate extraction. Industry policy statements commonly identify environmental and societal concerns and commit the company to environmental stewardship and interaction with the community.
- Objectives describe what is to be accomplished and commonly are subsets of the social, economic and environmental components of SARM. Typi-

cally objectives will include, but not be limited to: a) ensuring future supplies of aggregate; b) reducing the demand for newly mined aggregate, and c) protecting and restoring the environment (Langer, 2003b).

- Actions are associated with each objective and describe the steps to reach the objective.
- Indicators deserve special mention. They measure progress as well as the effects of efforts to protect and enhance natural and human systems and will be discussed in more detail below.
- Monitoring, feedback, and the regular reconsideration of requirements as events develop all help to refine the SARM process. The establishment of a joint monitoring process presents an excellent opportunity to forge partnerships with communities and involve citizen groups.

Minerals Indicators

From the steps described above more attention is given only to indicators due to the paper length. First, minerals indicators for European Union are described, and then some aggregate indicators within EU are presented.

There are three basic functions of indicators: simplification, quantification, and communication. Indicators of sustainability should be used as tools for knowledge, information transfer, as integral parts of other initiatives and sets of indicators, and as a solid base for decision making. The selected set of indicators should express a need for balance: (a) among stakeholders; (b) between the process of defining indicators and the set of chosen indicators, and (c) among the dimensions of sustainability (Šolar, 2003).

EU minerals indicators (Shields et al., 2005)

In May 2000, the European Commission published a Communication on "Promoting sustainable development of the EU non-energy extractive industry" (European Commission, 2000). Stakeholder dialogue was one of the important issues mentioned in this Communication that should be improved to achieve a more sustainable minerals industry. Indicators are a useful tool to create a platform for dialogue where different stakeholders are able to define, discuss and evaluate the performance of industry and its contribution to society. The indicators are to serve as a generally understandable means of communication between the different interest groups: (a) the companies, which can represent their economic, ecological and social welfare benefits vis-à-vis other stakeholders, (b) the national, regional and local administrations, which (depending on the legal conditions) examine these performances, and/or give access to land for mineral extraction, (c) the public (local, regional or national population, non-governmental organizations, media), whose interests are affected by existing or new sites.

A Working Group was set up in 2000 as a sub-group of the Raw Materials Supply Group. The Working Group, chaired by the Enterprise and Industry Directorate General, consisted of about 20 experts from industry, Member States, a university and an NGO. It was decided to develop the indicators taking a bottom-up approach and applying the characteristics used for the Global Reporting Initiative (GRI, 2000), i.e., that the indicators should have relevance, reliability, clarity, comparability, timeliness and verifiability. The work on indicators was limited to those phases of the production process that involved the extraction of raw materials, primary refining and the use of secondary raw materials.

Very early in the process a distinction had to be made between indicators at company/ site level and indicators at national (Member State) level.

As a result of indicator creation process the list of minerals' indicators was shortened to provide 13 priority indicators at company level, and 7 indicators at Member State level. They were not developed with a specific policy application in mind, but instead were chosen because they provided a useful picture of the sustainability of the industry, while the data collection requirements were considered to be achievable. The aim was to develop indicators, which can serve at the following scales/ levels as a common basis for dialogue for all involved interest groups: companies and/ or sites, industrial sectors, regional or national, and EU. Current status of the EU Minerals Indicator process is available on internet (http: // ec.europa.eu / enterprise / steel / non-energy-extractive-industry / sd-indicators.htm). Challenges and realities affecting the process are financial realities and difficulties in data collection. Commission's involvement is mainly to costs involving chairing and hosting meetings of the Working Group, some translation costs and hard copy publications. Industry federations and companies have mainly contributed involving people to the process of the Working Group, investing time and money in the data collection process and disseminating the results. The data collection in the SME-dominated sector has proven to be difficult, is further complicated by the business sensitivity of certain data (e.g. lime: energy efficiency), and in general it remains a constant challenge to motivate the companies to participate.

Aggregate Indicators (Langer et al., 2003)

Indicators for aggregates should support public awareness of issues related to sustainable resource management of aggregates and facilitate explicit consideration of the full range of costs and benefits of mineral development of aggregates. Mineral resource development, extraction, use and disposal are complex activities that can be described in many ways. It follows that there are multiple ways to organize mineral indicators. One method is to organize indicators according to the three dimensions of sustainability: economy, environment and society. An alternative is use a life cycle approach.

United Kingdom

In the United Kingdom, natural resource policy, including policies for aggregates, is covered by an overall national development document: "A Better Quality of Life: A Strategy for Sustainable Development for the United Kingdom" (United Kingdom, Department for Environment, Transport and Regions, 1999). In English counties, two levels of plans affect the Mineral Development Plans (HARRISON et al., 2002): (1) Structure plans that set out general principles and policies for all forms of development, and (2) Mineral Local Plans that set out detailed policies governing mineral extraction. (See http://www.qpa.org/sus_report01.htm for the UK Quarry Production Association report on SDI's for the aggregate sector).

Every county (minor administrative unit) is required by law to develop, implement and review a Mineral Local Plan. The Durham County Mineral Local Plan (COUNTY DURHAM, 2003) states that provision should be made for at least 82 million tonnes of aggregates per annum, and that part of crushed stone should come from recycling and re-using construction materials. Their stated objectives are to: (1) ensure the efficient use of resources, and (2) minimize the use of non-renewable resources. Each objective has targets and associated indicators. The target of the first objective is to maintain a landbank necessary to meet supply demands. This target is supported by following indicators: (a) the amount of mineral extracted per annum, (b) any changes in the landbank or permissions granted, (c) the viability of the existing landbank, (d) the level and type of employment activity within sector, and (e) changes in the landbank and permissions with Tees Valley. The second objective has a target to increase the production of secondary and recycled materials and implicitly to decrease production of primary materials. This target is observed by two indicators: (a) the amount of materials recycled per annum, and (b) the level and type of employment activity within the sector.

Italy

The Province of Modena, located in the Emilia Romagna Region in northern Italy, recognizes that natural aggregate and clay is necessary to sustain the economic well being of the region (LANGER et al., 2003a). Modena Province is preparing a Variant of the Intraregional Plan for Extractive Activities (PIAE) that has been in place in the Province since 1993 (PROVINCIA DI MODENA, 1995; 1996; 2000; 2001). One objective of the Variant of the PIAE is to minimize the impacts from quarrying and guarantee the reclamation of quarries in a manner consistent with the existing landscape. In order to accomplish that objective, the Emilia Romagna Region, in the 1993 PIAE, developed the innovative concept of the polo estrattivo, (extractive district). The polo estrattivo is not just one or more quarries, but is the whole of the area characterized by the prevalence of quarrying activities including the intervening and surrounding territory that is subject to quarrying impacts (LANGER et al., 2003a). A number of draft sustainability indicators were developed to support the Variant of the PIAE (LANGER et al., 2003a). Selected indicators for aggregates of the Modena Province are: (1) increase in number of poli from the old 1993 PIAE to the new Variant of PIAE, (2) ratio of area within poli converted to extraction versus area outside poli converted to extraction, (3) volume of aggregate produced per amount of surface area converted to extraction, (4) percentage of aggregate processing plants that have been moved into pits within a poli, (5) percentage of abandoned quarries that have been reclaimed, (6) percentage of perifluvial areas in need of reclamation that have been reclaimed, and (7) percentage of reclaimed quarry area that has been reclaimed as wetland areas.

Slovenia

Mineral resources, including construction materials, should be treated as integral to every country's overall sustainability considerations. Large infrastructure or building projects require substantial material inputs, and their provision should be handled in a manner that is consistent with sustainable development principles. Development of a sustainable mineral resource management plan, and creation of related indicators, will increase the likelihood of this occurring. The 1999 Slovenian Mining Act (partly revised in 2004) mandated the development of a mineral resource programme, the current draft of which is based on sustainability principles.

The indicator resides at the top of an information pyramid that provides a wide range of spatially dispersed information. While useful and informative, the indicator we present here cannot alone tell the complex story of sustainability. Rather it is intended as one of a set of indicators that, when taken together, describe how implementation the national mineral resource management programme is affecting the sustainability of Slovenia.

The case study addresses the sustainable supply of aggregates indicator for Slovenia that is based on policy goals of industry, government and civil society. The indicator is intended as one of a set of indicators that would tell about the trends of implementation the national mineral resource management programme. The latter is required by in 1999 passed mining act.

In Slovenia, the policy goals for aggregates are to secure the aggregate supply, eliminate illegal aggregate extraction, and reduce the overall number of aggregate extraction sites. The latter goal is strongly supported by public opinion on both the local and national scales, as well as by the land use planning and nature conservation authorities. These goals are included in the proposed National Mineral Resource Management Programme (NMRMP), required by the Mining Act. Elimination of illegal quarrying has two aspects: (1) stricter law and regulation implementation to stop the illegal activity, and (2) legalization of those quarries that fulfill land use and mining legal requirements. The mission of the NMRMP is stated to be ensuring minerals supply and land access by following sustainable development principles. One of the most important of those principles is stakeholder involvement; the plan to secure aggregate supply must reflect the objectives of various stakeholders. The desired outcome (included in NMRMP) is for a high number of legal quarry sites to have what are termed acceptable production and enough reserves/resources. For Slovenia, a "proper" quarry would have (acceptable) production annually between 50,000 and 500,000 tonnes, and (enough) reserves for between 10 and 50 years of average production. These levels were chosen so as to address the competing objectives of the stakeholders listed above. In Slovenia, there is so far only one "final" indicator, which resides at the top of a pyramid of primary (raw) and secondary (analysed) data. It is: »Percentage of "proper" quarry sites by administrative unit, across spatial scales, i.e., from municipality to country«.

Annual data needs will include the number of sites, their production, reserves, and resources of aggregates. These data are transformed into an indicator by combining them with land area (on 1,000 km^2, or on administrative, statistical units) and, as a proxy for demand, on population.

The sustainable supply of aggregates indicator is on the top of information pyramid that provides a wide range information that is spatially dispersed information and useful on different levels and to different stakeholders. The information pyramid includes auxiliary indicators, i.e., indicators of I and II. order. All information is stored in suitably organized databases that provide an easy access.

Conclusions

Natural aggregate is the number one non-energy mineral resource in the world in terms of value and volume and is a necessary commodity for sustainable communities. While it is a non-renewable resource, supplies of aggregate are nearly inexhaustible on a global scale. Natural aggregates have characteristics that differentiate them from most other mineral commodities: a high number of potential extraction sites, a high volume to value ratio, and regional importance combined with a narrow economic transportation radius. Because of these and other differences, resource management policies for aggregates should differ from "general" mineral resource policies, even though the end goal is the same for both – ensuring sustainable resource management. Beyond requiring traditional geo-technical, environmental and economic assessments, sustainable policy for aggregates should address: 1) construction material flows and quarry life cycle, 2) the public acceptability of quarries near human habitation, 3) optimizing present and future aggregates supply, including optimal use of current reserves, new locations, recycling, reuse, and substitutions, and 4) stress aggregate-extraction specific environmental and resource pressures. To achieve the goals of sustainable aggregate management each stakeholder – government, industry, the public, and non-governmental organizations – will need to accept certain responsibilities, one of the most important of which is to become informed about natural resource issues. Sustainability is about making trade offs among competing objectives and people disagree about the appropriate balance among the goals of economic prosperity, social equity and environmental health. One of the primary purposes of mineral indicators is to provide information to decision makers and the public so as to ensure that the public debate about policy choices is grounded in fact.

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Povzetek

Trajnostni razvoj in mineralne surovine za gradbeništvo: izbrana (evropska) vprašanja in primeri prakse

Med mineralnimi surovinami so mineralne surovine za gradbeništvo po količini in vrednosti najpomembnejše in predstavljajo del želene prihodnosti človeštva. Kljub temu, da so neobnovljiv vir, je možna skoraj neomejena oskrba z njimi. Mineralne surovine se razlikujejo od večine drugih surovin po velikem številu možnih lokacij pridobivanja, po velikih odkopanih količinah, nizki ceni surovine ter po njenem regionalnem pomenu glede na omejitev z višino transportnih stroškov. Zaradi teh in drugih posebnosti je potrebno, da se tudi usmeritve gospodarjenja z njimi razlikujejo od gospodarjenja z drugimi mineralnimi surovinami, čeprav je za vse enoten cilj: zagotavljanje gospodarjenja po načelih trajnostnega razvoja. Poleg zahtevanih rudarskih, okoljskih in ekonomskih ocen in vrednotenj, naj bi trajnostne usmeritve / politike za mineralne surovine za gradbeništvo obsegale tudi: (a) oblikovanje snovnih tokov materiala in življenjski cikel odkopa, (b) družbeno sprejemljivost odkopov v bližini naselij, (c) optimizirane sedanje in prihodnje oskrbe, vključno z optimalno rabo sedanjih zalog, novih lokacij, recikliranja, ponovne uporabe in zamenjave materialov ter (d) poudarek na specifičnih okoljskih negativnih vplivih. Za dosego želenih ciljev je potrebno, da vsi udeleženci (vlada, industrija, javnost, nevladne organizacije) prevzamejo odgovornost, od katerih je ena najpomembnejših prav zanesljivo in pravočasno informiranje. Trajnostni razvoj vključuje izbiro med več možnostmi glede na vrednote, želje in cilje posameznih vpletenih delov družbe. Zaradi tega je težko doseči ravnotežje med ekonomskim napredkom, družbeno enakostjo ter zdravim okoljem. Osnovna naloga kazalcev je informiranje javnosti, da javna razprava temelji na ustreznih in zanesljivih argumentih.

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