WASTE MANAGEMENT AS PART OF RESOURCE MANAGEMENT WITHIN THE CONTEXT OF SUSTAINBILITY

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ABSTRACT

Sustainable development became the prevailing policy paradigm by the turn of the millennium. Human activities should be conducted according to sustainability principles so as to further progress toward the goals of economic prosperity, environmental health, and social equity. Views on how these goals are envisioned and how they could be achieved differ within societies and across nations. Fortunately the principles are flexible and can be interpreted in different ways. As applied to minerals, the main goals of sustainable resource management are to maintain the stream of benefits to society and to do so in a manner that results in a net benefit to society over the life of the mine and the product. The aim of waste management is to mitigate all the undesired impacts waste, or, in other words, turn wastes to non-wastes. The aim of this paper is to demonstrate that some core concepts used in sustainable resource management can be applied also to waste management and vise versa. In doing so, resources and wastes can be more integrated, and not separated as desired or undesired outcomes of the production process. Resource and waste management intersect in particular in mining and construction activities.

Key words: sustainability, resource management, mining and construction wastes, dematerialization.

INTRODUCTION

Present social and environmental problems 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, 2003). They are not necessarily all achievable at the same place and time. Thus, sustainability is about making trade-offs among competing objectives. Sustainability is not science per se, although it uses science to achieve societal goals. Rather it is a value statement about the world we want to live in and leave to future generations, and such human values are not fixed and independent of social, economic, and ecological context (Šolar et al., 2004). People disagree about the appropriate balance among the mentioned above goals because preferences and values differ across and within societies (Langer et al., 2003).

Natural (renewable and nonrenewable) resources are integral components of economic, environmental, and social systems; it is essential that they be included in any comprehensive framework for long term development and prosperity. As a result, many countries have embraced sustainability as the appropriate paradigm for resource and waste management in the 21st century. In this paper, we present a sustainable mineral resource management framework that has as its twin goals: sustaining the stream of benefits that are provided to society by minerals, and doing so in a manner such that those benefits are a net positive over the mine and product life cycle (Šolar & Shields, 2005). We then demonstrate that this framework is also applicable to (mineral) waste management.

SUSTAINABLE DEVELOPMENT AND ITS APPLICATION TO NATURAL (MINERAL) RESOURCES

The purpose of mining is the extraction of valuable minerals or other geological materials from the earth, usually (but not always) from an ore body, vein, or (coal) seam. Materials commonly recovered by mining include bauxite, coal, copper, diamonds, iron, gold, lead, manganese, magnesium, nickel, phosphate, platinum, salt, silver, tin, titanium, uranium, and zinc. Other highly useful materials that are mined include clay, sand, cinder, gravel, granite, and limestone. These resources are almost entirely nonrenewable; an individual deposit cannot be recreated except through natural geological processes. Many minerals can, however, be recycled, for example aluminum and demolition wastes.

Discussions about the role of natural resources in sustainability tend to focus on the need to sustain ecosystems and maintain biodiversity. For example, sustainable forest management requires that the capacity of forests to maintain their health, productivity, diversity, and overall integrity be protected, in the long run, in the context of human activity (USDA FS 2004). The fundamental goal is sustaining the ecosystem. Minerals are as essential to a sustainable future as are ecosystems, but it is counter intuitive to speak of them as being sustainable in the same way. Individual deposits are finite in size and quantity. On a broader, global scale, minerals are seldom truly exhausted in any case, but rather redistributed from their location in deposits to products and waste materials.

There are several streams of thought on how minerals fit in sustainable development. One perspective focuses on mineral development as a source of wealth creation and by extension its value as tool for the eradication of poverty. Another focuses on present and future needs for minerals and fuels and points out that developed societies need a steady supply of material inputs because mineral resources are fundamental to human well-being. They provide essential services to societies – fuel for transportation, mineral materials that are the basis of the built environment, and metals that are widely used in consumer products. Neither present nor future societies can be expected to forego the stream of benefits coming from the use of mineral resource products, and by extension from mining. A corollary of this perspective focuses on the demand side rather than on the supply side and argues that a reduction in the per capita use of materials by the developed world will be essential to the achievement of sustainability. A third perspective focuses on the negative environmental and social consequences of mineral development, use and disposal, on the legacy of abandoned mines, acid mine drainage, and boom-bust economic cycles.

Over the past ten years, public discourse on the compatibility of mining and sustainability has progressed from disbelief and rejection, to skepticism, to general acceptance. The basic reason for this shift 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, legislation, regulation and management that promote and support sustainable behaviors and outcomes.

SUSTAINABLE MINERAL RESOURCE MANAGEMENT

According the Bringezu (2006), sustainable resource management takes a pyramidal form. At the top are four main goals: dematerialization, factor 4/10, broad discussion, and indicators for orientation. Achievement of these goals is supported from below by improved information (EU to household scale, institutional and technological potential for improvement; good-practice examples; education and training), and incentive frameworks (market based instruments (subsidies, taxes, etc), planning (extraction licenses and construction standards), and standards for sustainable cultivation (organic farming).

Sustainable mineral resource management (SMRM) does not place consumption at the center of its approach, but rather focuses on the sustainable management of mineral resource activities. The goal of SMRM is neither to limit production, nor to sustain a single deposit or mine, but rather to sustain the flow of benefits and services from those resources in such a way that their contribution to society over the life cycle is net positive (Shields & Šolar, 2004).

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 as alluded to above (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. (Šolar et al., 2006).

There are many ways to manage mineral resources. A government could dictate to industry and to society where mines must be and what size they should be, but that approach would be inconsistent with both democratic institutions and principles of sustainable development as they apply to mining. It would contradict two cornerstones of intra-generational equity: transparency and public participation in decision making. Conversely, a government could create resource management policies that are responsive to public concerns. The open question is – whose concerns. If the general public is uninformed about resource management issues, policies may unduly reflect the concerns of powerful special interest groups, be they industry or environmentally oriented.

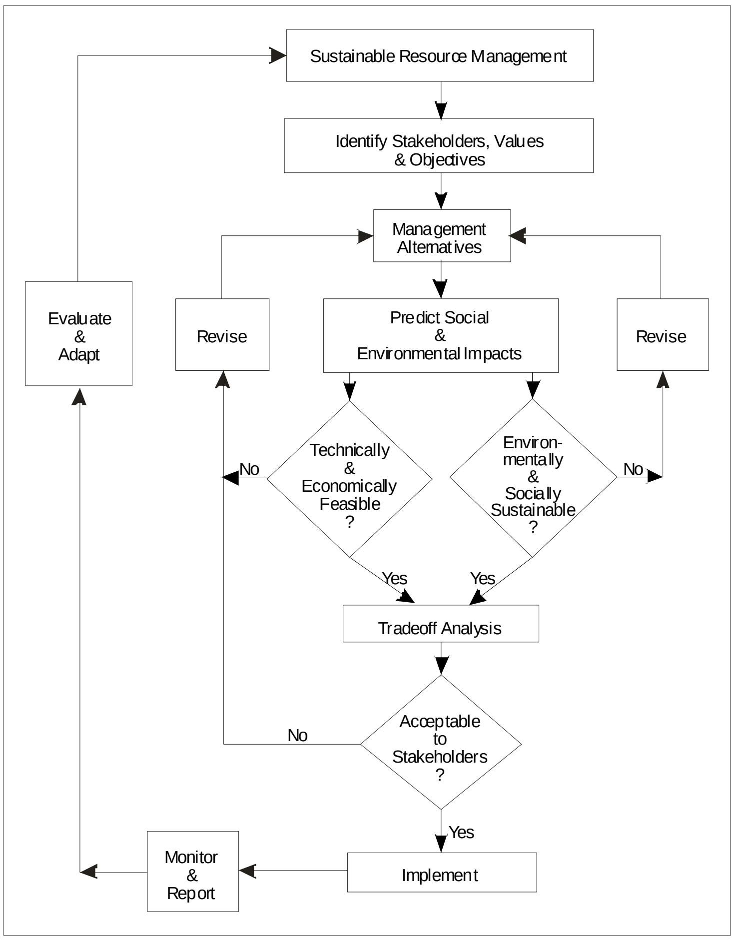

Diagram 1.: Implementation of sustainable resource (and also waste?) management.

SMRM is a more pluralistic approach to policy development that is based on extensive public participation in decision making processes. Such public involvement is only meaningful and productive when citizens have access to sufficient, accurate, and understandable information. In the case of aggregates, for example, adequate information is not currently available and that which is available is not presented in a manner that is easily interpreted. We recommend that data be condensed and presented to the public in the form of indicators. It is not realistic to expect the general public to become knowledgeable about the details of resource management or be able to interpret technical information or raw data. Once the public has gained an awareness of issues related to aggregate resource management, they will be able to engage in informed public debate about resource policy.

SMRM provides a framework for developing such policies through a fair, democratic, and transparent process (Shields & Šolar 2004).

SMRM is an iterative, adaptive process that can be illustrated with a flow chart (Diagram 1). It starts from the premise that people's objectives are value based and context dependent. Therefore, the SMRM process begins with the identification of stakeholders, their value sets and related objectives for resource management (Figure 1). Alternative management approaches are developed that reflect those objectives. Social and environmental impacts are predicted for each alternative, technical aspects are considered, and costs estimated. Technically or economically infeasible, or unsustainable, alternatives are revised or rejected. Feasible alternatives that support sustainable outcomes are then presented to the public for debate and negotiation with the goal of choosing an alternative that is acceptable to the public. Once an acceptable management alternative has been identified, it is implemented, monitored, evaluated, and revised as needed. The process of revision once again requires public participation and the cycle is repeated. (Shields & Šolar 2006).

WASTE MANAGEMENT

Waste is an inevitable outcome of the production and use of products. The degree to which waste is perceived to be a problem is a function of its volume, characteristics, ease of disposal, degree of environmental impact, and public preferences. According to the dictionary, waste is the state of or act of squandering resources, the misuse, neglect or failure take advantage of something. Even though waste is integral to production, waste quantity and toxicity can be minimized through sound policy and management.

Waste management has many definitions. Most basically, it is the collection, transport, processing, recycling or disposal of waste materials, usually ones produced by human activity, in an effort to reduce their effect on human or environmental health, or amenities. Thus, waste management is the control of waste-related activities with the aim of protecting society and the environment, and conserving resources (Pongracz, 2002).

Core concepts related to waste management include the waste hierarchy, extended producer responsibility, product stewardship, and the polluter pays principle, among others. Here we address only the first. The waste hierarchy is the priority order for dealing with waste.. The European Council in June 2007 agreed to maintain a so-called "five step" hierarchy (European Topic Centre on Resource and Waste Management., 2007). The order of preference is:

1. prevention of waste;
2. re-use of products;
3. recycling/composting;
4. recovery of energy by incineration, and;
5. landfill disposal.

The order of preference above is consistent with Bringezu's goal of dematerialization, but lacked a broader sustainability context. In the Sixth Environment Action Programme of the European Community - Environment 2010: Our Future, Our Choice, the European Commission presents sustainable use of natural resources and management of wastes as one of four priority areas. This has led to the development of two thematic strategies on resource and waste management, the second of which addresses sustainability:

- Thematic strategy on the prevention and recycling of waste
- Thematic strategy on the sustainable use of natural resources

EU resource policy puts decoupling resource use from GDP (to increase resource productivity) and resource use from environmental impact (to reduce resource specific impacts) in the center of European resource strategy. In both cases, waste reduction is expected. Policies for reducing the environmental impacts, and increasing utility of material use with action based on improved orientation, information and incentives. Reducing the primary materials and use of secondary ones (reused or recycled) are among the general guidelines towards sustainability.

In both thematic strategies, the life-cycle approach is emphasized as an important part of the work. More knowledge is needed on the pressures that waste generation and waste management exert on the environment, and their links to possible impacts. Life-cycle thinking brings close together resource and waste management. The European Commission's Institute for Environment and Sustainability - Ispra Joint Research Centre (JRC) has a working group who builds knowledge of the use of LCA on waste and resources (European Topic Centre on Resource and Waste Management., 2007).

Turning back to the mining sector, waste can be categorized as of two types: non-toxic, non-hazardous, and inert materials that are not used in processing or sold as products, and materials generally recognized to be and treated as waste, including left over lubricants, toxic chemicals, used tires, and dissipated energy. The industry treats the former category as left-over materials that have the potential to become useful at some point in the future not waste. Nonetheless, they are often problematic substances for civil society due to their large volumes, which present disposal challenges. Turning such wastes to non-waste (products) without (or at least negligible) environmental and social impact is in accordance with the EU general sustainability framework and with SMRM. In the case of minerals this would mean turning the large volume, inert (or non-hazardous) mining wastes into a resource, perhaps for land reclamation (Mitchell et al., 2004).

Life cycle assessment (LCA) is a tool widely in use in the minerals industry to determine the total environmental impact of a design or a product to be analyzed. Conducting LCA can contribute to sustainability in a number of ways. First, analysis of current operations can identify inefficiencies, points where process redesign will lead to lower costs and fewer emissions, i.e., waste reduction. Second, the results of LCA can be used to identify materials previously thought of as wastes, that can be put to productive use. The same type of activity is happening at the regional level using material flow analysis (Moll et al., 2005).

The flow diagram previously presented can also illustrate an implementation process for sustainable waste management. As in the case of minerals management, waste management must start with public preferences if actions taken are to be accepted and supported by society. And similarly, there are many approaches to waste management, each with attendant costs and benefits. Once choices are made, then implementation, monitoring, and adaptation must follow if waste strategies are to be successful.

CONCLUSIONS

The way of organizing thinking about and choosing among alternatives for production methods and material handling as proposed by SMRM can assist firms and societies in making choices about waste management regimes. The added value of integration resource and waste management is material efficiency, and by extension increased likelihood of the achievement of societal sustainability goals. Material efficiency as part of eco-efficiency can be rewarded by governmental initiatives (tax reductions, subsidies, research grants, etc.).

REFERENCES

(1) Bringezu S.: Materializing Policies for Sustainable Use and Economy-wide Management of Resources: Biophysical Perspectives, Socio-Economic Options and a Dual Approach for the European Union. . Wuppertal Papers No. 160. Wuppertal Institute for Climate, Environment and Energy. pp. 37. June 2006.

(2) European Topic Centre on Resource and Waste Management. Topic Centre of European Environment Agency (available on internet July 5, 2007 http://waste.eionet.europa.eu/lca).

(3) Langer, W. H., Šolar, S. V., Shields, D. J., Giusti, C. Sustainability indicators for aggregates. In: Agioutantis, Z. (ed.). Proceedings of the International Conference on Sustainable Development Indicators in the Mineral Industries. Milos: Milos Conference Center - George Eliopoulos, 2003, pp. 251-257.

(4) Mitchell, C.J., Harrison D.J.,Robinson H.L.,Ghazireh N., Minerals from Waste: recent BGS and Tarmac experience in finding uses for mine and quarry waste. Minerals Engineering, Vol.17 No.2, 2004.

(5) Moll S., Bringezu S. & Schütz H.: Resource Use in European Countries. An Estimate of materials and waste streams in the Community, including imports and exports using the instrument of material flow analysis. Wuppertal Report No. 1. Wuppertal Institute for Climate, Environment and Energy. pp. 103. December 2005.

(6) Pongráz E.: Re-defining the Concepts of Waste and Waste Management. Evoloving the Theory of Waste Management. PhD Dissertation. Department pf Process and Environmental Engineering, Unviersity of Oulu. Finland. pp. 166. 2002.

(7) Shields, D. J. & Šolar, S. V. Sustainable mineral resource management and indicators: case study Slovenia. Ljubljana: Geological Survey of Slovenia, 84 pp. 2004

(8) Shields, D. J. & Šolar, S. V. The nature and evolution of mineral supply choices. In: Cardu, M. (ed.), Ciccu, R. (ed.), Lovera, E. (ed.), Michelotte, E. (ed.). 15th International Symposium on Mine Planning and Equipment Selection, Torino, 20-22 September 2006. Mine planning and equipment selection 2006. Torino, pp. 902-907, 2006.

(9) Šolar, S. V., Long-term spatial planning and mineral resource management - case study: aggregates in Slovenia. In: 4th European Congress on Regional Geoscientific Cartography and Information Systems: proceedings. Bologna. Italy pp. 680-682. 2003

(10) Šolar, S.V., Shields, D. J., Langer, W. H. The main features of sustainable aggregate resource management = Značajne karakteristike održivog gospodarenja sa agregatima - mineralnim sirovinama za građevinarstvo. In: Osmanagić, M. (ed.), Bijedić, Dž. (ed.), Handzo, M. (ed.). European Conference on Raw Building Materials and Coal: New Perspectives, Sarajevo, May 20th 2004 : book of plenary parers [i.e. papers] : knjiga plenarnih referata. Sarajevo: IP Svjetlost, pp. 389-402, 2004.

(11) Šolar S. V., Shields, D. J. Applying sustainability principles to the exploitation of mineral deposits. In: Pezdič, J. (ed.), Boev, B. (ed.). *Anthropogenic effects on the human environment in Tertiary basins in the Mediter[r]anean*. Ljubljana; Skopje: Geology Department of University in Ljubljana, pp. 6-10, 2005.

(12) Šolar, S. V., Shields, D. J., Langer, W. H., Anciaux, P. Sustainability and aggregates: selected (European) issues and cases = Sürdürülebilirlik ve agrega madenciligi: Avrupa'dan mevzuatlar ve Örnekler. V: Yuce, A. E. (ed.), Kuzu, C. (ed.), Guney, A. (ed.), Erdogan, M. (ed.). 4. Ulusal Kirmataş Sempozyumu Agrega (Beton, Asfalt), Çimento Hammaddeleri Madenciligi, Istanbul, 1-2 Aralik 2006. *Bildiriler kitabi*. Istanbul. pp. 1-10, 2006.

(13) USDA Forest Service (USDA FS 2004): National Report on Sustainable Forests – 2003. FS-766. Government Printing Office, Washington, D.C. 2004.