[1]Deep Impact: Coping with the Consequences of Reshaping our Landscapes exemplified at Open Cast Mining

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ABSTRACT

Primarily open-cast mining activities have led to radical alterations of the affected landscape unlike other human impacts on the earth's surface. Resulting from images of the destroyed prior landscapes there is a desire and there are plans to redesign these areas into more natural landscapes. But, in fact, post-mining landscapes do not represent the same landscape functionality and structure as they held before. Unlike the idea of resilience or the capacity to absorb disturbance, or complexity theory describing processes of adaptation and emergence, post-mining landscapes as we understand it are completely new landscapes including its socio-economic features which has been invented and not adapted to something. Since these new landscapes contain functions of the prior and structures of a new system, a systemic view on these "fundamentally altered landscape" seems appropriate that bases on existing knowledge on the former landscape and opens the floor for new feedbacks. To introduce such an approach is the purpose of the paper. Based on an exhaustive literature review we will discuss shortcomings of existing impact assessment approaches used for mining activities and potentials as regards the strict integration of social and ecological factors in order to suggest a more system-dynamics based evaluation approach that can be applied to foreseeable big impacts. Its novelty lies in the explicit incorporation of social science findings and methods as well as the formulation of feedback loops from impact to driver in order to incorporate unexpected changes which normally fall into the domain of ignorance.

INTRODUCTION

Unlike other human impacts on the earth's surface, open-cast mining activities have led to radical alterations of landscapes. Resulting from images of destroyed landscapes there is a desire and there are plans to reshape these areas into more natural landscapes. However, post-mining landscapes do not represent the same landscape functionality and structure as the ones before. Unlike the idea of resilience or the capacity to absorb disturbance (Holling 1978, Gunderson and Holling 2002), or issues discussed in complexity theory such as processes of adaptation and emergence (Chettiparamb, 2006; Byrne, 2003; Innes and Booher, 1999), post-mining landscapes, as we refer to them, are completely new landscapes including novel socio-economic features which have been invented. Although these new landscapes still may contain some of the functions of the prior landscape, more often than not, after the impact a completely new social and ecological structure can arise that cannot be modelled along blueprints from former times. Furthermore, many of the assessments are fundamentally limited by ignorance. Consequently, a systemic view on these "totally new landscapes" seems appropriate, which is based on some existing knowledge on the "old" landscape but pivotally is open to new and, in this sense, "unexpected" feedbacks. To introduce such an approach we have chosen the development of open-cast lignite mines.

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FUTURE CHALLENGES OF POST-MINING LANDSCAPES

Especially in areas where coal lies close to the earth's surface, mining activities have led to radical alterations of the landscape like in no other human activity affecting the earth's surface. For coal and lignite mining, the option of complete backfilling of the mines is hardly available. The volume of former coal or lignite seams may be replaced by waste materials or pit lakes, often in areas that have been "lake-less" for millennia. Massive alteration of surface substrates and groundwater is one of the many environmental consequences, so that in mining regions the groundwater table can drop for 100 meters or more during mining operations.

Overall, open cast lignite mining for coal and lignite has an enormous impact on the development of industrial locations, the development and relocation of settlements, land use, and landscape development. Coal is not only the basis for many industries, but even today provides a significant amount of the world's energy supply. In 2006, coal and lignite contributed 26% (3053.54 million tones of oil equivalents) to the total primary energy supply of the world (IEA, 2008). The current debate about more alternatives for oil has brought back an energy source that until quite recently was rendered a "dirty energy," at least nothing that was filed under the label of "alternative energy." Although on an overall level mining activities declined considerably in industrialized countries during the last three decades, there are fields such as bituminous coal mining, which have been on the rise worldwide at the same time. The production of bituminous coal of Europe follows the mentioned trend for industrialized countries. Quite unexpectedly, also in North America a nearly continuous growth of coal production occurred over the last almost 30 years following the worldwide trend. However, only a relatively small part of bituminous coal is produced in open cast mines. In contrast to bituminous coal, lignite mining which for the most part has been excavated via open cast mining operations has decreased over the last 17 years. However, quite unexpectedly, in many countries such as Turkey, India and Australia, the production has been growing. All over Europe, old coal mining fields are being regenerated in many different ways, but, in most cases, there is a desire to redesign the target areas into more natural areas first. Of course, this landscape is substantially different from the landscape before mining was begun. Our approach outlined below attempts to take seriously that these so called post-mining landscapes do not retain essentially the same function structure identity, and feedbacks after a period of crisis, or what Holling and others (1978; 2002) have labeled the resilience or the capacity to absorb disturbance. Instead, the "total" landscape including its socio-economic dimensions can be all new. It has, one could say, been invented and not adapted to a former state (Turner 1994). Taking these issues seriously, it is our humble goal to outline a conceptual strategy of an ex-ante impact assessment that includes the participation by as many of the actors involved with a major focus on the sense of well-being of the local, but moving away from the idea that the post-mining order will or needs to have the same function, structure, and identity as did the pre-mining landscape. In our approach we will exactly aim at the uniqueness of open cast mining, which means a fundamentally new type of settlement organization, land use and landscape design, which does not even resemble the "pre-disturbance" appearance.

IMPACT ASSESSMENT FOR LANDSCAPE ALTERATIONS – IALA

As discussed above our goal is to enhance existing impact assessment systems developing a system dynamics-based impact assessment approach for radical landscape alterations (IALA) exemplified at mining impacts. The stylized system model in Figure 1 serves to illustrate the major elements and innovations of IALA. Radical landscape alterations mean changes that bring up either completely new surfaces such as lakes in formerly lake-free landscapes, recreational zones in former agricultural areas, a reversed settlement structure, but also a completely new educational structure of the population, population exodus or re-settlement (represented by the central variable “Environment” in the stylized model of Figure 1).

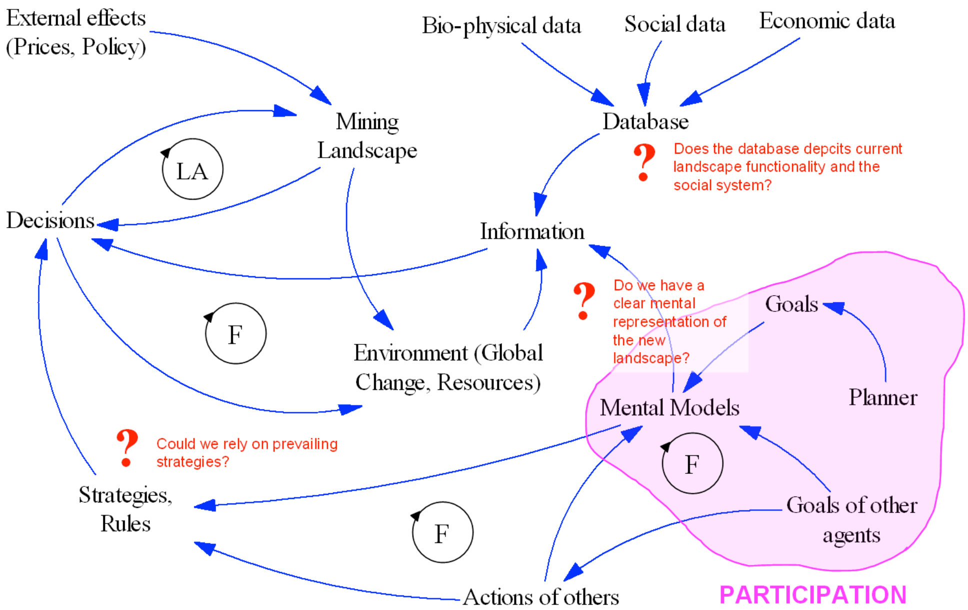

Figure 1 The system dynamics approach of IALA where LA is the landscape alteration and F another feedback loop resulting from stakeholder or public participation. Uncertainties in the system and decision-making result from radical landscape alterations.

These changes further comprise altered matter and water flows such as acidification of formerly covered sediments (e.g. Pyrite oxidation), river-course modifications or (timely limited) dropped groundwater levels and the disappearance of floodplains. Radical landscape changes explicitly include negative but also positive changes (based on prevailing knowledge). In terms of a mining impact, we assume that next to the radical alteration of the physical landscape the new or radically altered landscapes are characterized by different energy and matter fluxes, biological life and socio-economic potential. For those, a system dynamics is applied either to a known system or to foreseeable socio-environmental impacts of a mine. It can also deal with unexpected changes by using the same functional relationships but applying them to extreme values or using altered polarities to e.g. grasp potential benefits of the mining impact or of the opportunity to create a new landscape (for recreational purposes for example) instead of quantifying the “loss of landscape” due to mining. This usage of existing knowledge and data to uncover new landscape relationships is represented by the variable “Database” in the stylized model of Figure 1. Simultaneously, there is uncertainty assigned to this variable as we do not know weather a database of the former landscape entails enough information for understanding a new one. Here, (stakeholder and public) participation as a means to uncover heuristics in decision-making under conditions of uncertainty will be a key to cope with uncertainty and things still unknown.

The novelty of IALA lies firstly, in the explicit incorporation of social science methods and findings in the SD model (represented by the variables “Mental models”, “Strategies” and “Decisions” in Figure 1), secondly, in the formulation of feedback loops resulting from such radical landscape changes towards society and economy (drivers of mining) and, thirdly, the formulation of adaptation options to unexpected changes which in daily planning completely fall into the domain of ignorance (Burt, 2007). This is what we understand by feedback-loop-learning including feedback-views (Sterman, 2000). This is a crucial element. To put it somewhat differently, successfully coping with radical landscape changes outlined above always depends on ignorance. In our model, however, we do not treat uncertainty and ignorance as something to be avoided, but as a source for new knowledge. By so doing, IALA pivotally considers stakeholder and public participation from the beginning as it is seen as a driving component in "creating" new landscapes. In order to provide evidence of participation benefits we incorporate real world decision-making such as life long learning organization into the built-up phase of the SD model. In doing so, we suggest new hybrid social-computer-science methodologies such as mental and group model-building and scenario games to (1) elicitate decision-making behavioural heuristics, (2) translate the suggested feedback loops into decision-making, and (3) make inherent uncertainties explicit when incorporating trust or collective learning to point to absorption measures to deal with radical change. Many forms of participation have been discussed and also have been criticized. In many cases, participation still needs to be proven as an indispensable element of landscape development. However, we aim to suggest that early involvement of stakeholders is an indispensable goal to shaping new landscapes and developing options of sustainable development (Agrawal and Gibson 2001, Küffer 2006, Renn et al. 1995).

By means of completion, our suggestion for an impact assessment for radical landscape alterations (IALA) has focused on the importance to deal with ecological and social unknowns in the planning of future post-mining landscapes which qualitatively differ from other landscape alterations, such as the revitalization of contaminated sites or the restoration of degraded ecosystems. With the model that we outlined above, unexpected events based on ignorance and uncertainty can be coped with via processes of recursive loops. Ideally the result can lead to more reliable knowledge, which can be used recursively linked to produce new knowledge based on unexpected turns in the process of the development of a new landscape. This type of understanding of the system dynamics in landscape alterations via repeated feedback loops of learning – whether originating in changing social goals and values through stakeholder participation or unexpected ecological changes – thus are a first step to model the learning process in such a way that radical changes can be absorbed without bringing a landscape development project to a halt.

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