Interdisciplinarity and Responsibility for Land Use, GIS and Eco-systems
Some problems of social traps

Hans Lenk

Institut für Philosophie, Karlsruhe Institute of Technology, Germany
E-Mail: hans.lenk@kit.edu

Abstract
Interdisciplinary studies and cooperations are necessary for practical work as well as studies in geodesy. Responsibility is a function of power, impact and knowledge. The more strategically central one's position is in terms of power, influence and knowledge, the higher one's responsibility is. This is an idea which can be worked out in more detail by using interdisciplinary approaches and distributive models on different levels. Social traps, Prisoners' Dilemma situations etc. as pertaining to land, soil, and environment as well as some examples from geodesics and the study of the usage of nature systems like lakes and flood plain areas are discussed regarding responsibility and distribution problems. "Naturalists' Dilemmas" (or "Enjoyers' Dilemmas") are sketched and potentially solved by proposing a viable distribution strategy.

1 Interdisciplinary studies are necessary also for geodesy, GISs etc.

Methodologically speaking and also in engineering and planning practice different sorts of interdisciplinary cooperations seem to be conducive and even necessary in geodesics as an earlier study (by Lenk et al., 1998) hypothesized and partially substantiated. In this preliminary article different kinds of interdisciplinary cooperation were mentioned as being useful in geodesy, notably for applying GIS models. We sketched the application of some such cooperation forms for examples of flood plain area management problems in England. Here is a short introductory outline of the paper:

"A specific example project of an interdisciplinary integrated floodplain area development based on GIS methods was used to highlight some of the modeling, data acquisition and data integration problems as well as the interdisciplinary function of GISs in this realm of research and planning (theory).[. . .]

There is a rather encompassing trend towards cross-disciplinary systems in an ever more interlaced world which is to a considerable part encroached on by man. This development comprises complex systemic trends getting ever more comprehensive impact to manipulate and reshape if not revolutionize our environment and the social world. We seem to live in a rather "socio-technological", largely man-made systems-technological and thus in a sense "artificial(ized)" world.

Systems methods and methodologies prevail. This trend is to be found in all science-induced technological developments as well as in administrations. Besides systems theory in the narrow sense the mentioned methods are characterized by operations technologies led by (methodical or even methodological) process

Erschienen bei KIT Scientific Publishing
Schriftenreihe des Studiengangs
Geodäsie und Geoinformatik 2018,1

DOI Einzelbeitrag:
10.5445/KSP/1000080234

Festschrift zur Verabschiedung von
Prof. Dr.-Ing. Dr. h.c. Bernhard Heck
(Schw)Ehre, wem (Schw)Ehre gebührt

DOI Festschrift:
10.5445/KSP/1000080324

controlling and systems engineering, by operations research etc. Moreover, methodological assessment as articulated in philosophy of science is necessary.

In general, digitalization, abstraction, formalization and concentration on the operational procedures as articulated is essential. It is by the way of computerization and informatization as well as by using of formal and functional operations technologies (e. g. flow charts, network approaches etc.) that the formal essentials of increasingly comprehensive processes, organizations as well as the interrelations of different fields and subfields are integrated. Information technologies lead the way.

For comprehensive systems engineering or system technology, it is indeed characteristic that the different technological developments including economic and industrial changes lead to system(at)ic interaction and generally to a kind of systems acceleration across different fields. (This is a trend which had been predicted by Gottl-Ottlililienfeld (1923) in 1913. He had already described mutually interactive spill-over effects, ramifications across traditional realms and a sort of what we nowadays would call positive feed-back processes.) All these ongoing processes necessarily require a far-reaching, if not encompassing interdisciplinary interaction and stimulation (*inter-stimulation*). Indeed, interdisciplinarity led by spillovers from science to science and from there to technological development and innovation plus implementation as well as to society at large is prominent nowadays. Systems analyses and systems technologies require interdisciplinary approaches in practice. The pertinent challenges within this *world of systems* including techno-systems (in fact socio-technical systems combined with social and ecosystems) requires a thorough methodological study for the types of interdisciplinarity in research and development and practise.

Short of providing such a methodological analysis here, it may suffice just to mention that one has to elaborate criteria for the methodological distinction of disciplines according to the objects and areas as well as scopes of the research, development and prospective implementation. Relevant (arsenals of) methods and knowledge interests (Habermas) have to be articulated and the relationship between theory and practice should be studied. Methodologically important is the difference between theories and their systematic and historical connections and contexts, substantivity vs. operationality of theories (substantive vs. operative or procedural theories) (Bunge, 1967). One has to specify from a philosophy of science perspective the extant patterns of explanation and systematization (descriptive versus explanatory, historical versus systematical) and questions of cognitivity and normativity (descriptive versus normative approaches and practical combinations).

These perspectives lead to different types of bi- and multilateral interdisciplinary relationships between the respective disciplines of these as, e. g., in GIS engineering. Stages of the more or less strong, formal and law-based interpenetration or merely aggregative coordination are reflected in the following.

Types of Interdisciplinarity:

1) interdisciplinary co-operation in more or less well-defined projects (e. g. GIS in geology)
2) bidisciplinary or interdisciplinary research area (like satellite geodesy)
3) multidisciplinary aggregate field of research (e. g. environmental research)
4) genuive *interdiscipline* (like physical chemistry or biochemistry)
5) multidiscipline resulting from/relying on multidisciplinary theoretical integration
6) abstract generalized interdisciplinary systems theories (e. g. general systems theory)
7) mathematical theories of abstract and complex dynamical systems (e. g. deterministic or an as yet less developed probabilistic chaos theory)
8) supra-disciplinary abstract structure-analytic and operational disciplines (e. g. operations research)
9) methodological supra-discipline as e. g. philosophy of science and science of science
10) philosophical and methodological epistemology as a meta-disciplinary approach (e. g., methodological schema interpretationism, cf. Lenk (1993)).

At first, we have the co-operation of different experts for or within a developmental programme, as e. g. in a coastal zone management (CZM) planning where experts from different fields like geography, cartography, hydrography, geodesy, biology and ecology, limnology or oceanography as well as engineering in dike-building and landscape planning have cooperated (cf. Lenk et al., 1998). Secondly, an interdisciplinary or bidisciplinary realm of research like satellite geodesy might evolve or, thirdly, even a multidisciplinary aggregative research area as, e. g., environmental research (systematic ecology). The fourth level or step of co-operative integration would amount to a real interdiscipline (like molecular biology or population genetics) or, fifthly, a multidiscipline in the more specific sense (multidisciplinary theoretical integration) (for instance the integration of natural and social science approaches in systems engineering of eco-techno-sociosystems, e. g. diked areas and CZM. The sixth through eighth levels are formal theories of an abstract mathematical brand being used as instrumental vehicles of modeling real or constructed systems - including approaches in Social Impact Analyses of geosystems engineering. Furthermore, the metatheoretical levels 9 and 10 are addressed on a higher stage of methodological or epistemological (meta-)analyses (e. g. philosophical, social and methodological assessments).

Interesting questions regarding GISs and their application to CZM are:

a) On what level are actual and potential interdisciplinary co-operations in both of these fields to be located?
b) How can possibly and already do levels and types of interdisciplinary interact with one another?
c) Is it possible to distinguish and effectively separate descriptive and normative, i. e. prescriptive or (e)valuative, utilization of interdisciplinary modeling, e. g. with regard to factual ("cognitive") *and* interest or value conflicts, respectively?
d) Can we neatly distinguish between scientific and purely descriptive analyses and evaluative approaches in the practice of systems planning, to wit, e. g., coastal or shore zone management?
e) To what extent are values, goals and interests ("humanware" so to say) indispensable moderating variables for any application of GISs and planning procedures, e. g. coastal management acts and plans? [...]

With respect to the evolved types or stages of interdisciplinarity, we would hypothesize and argue that the practical elaboration of GISs and the interdisciplinary collaboration in landscape, land-use and coastal as well as lake and river shore management have thus far not progressed beyond step 3 as in the list of types of interdisciplinarity above (if not only step 2) and will in the foreseeable future hardly reach level 5 of a really theoretical multidisciplinary integration. (This judgement is based on the rather as yet underdeveloped stage of the theoretical integration of natural and social science approaches in general and notably with respect to sociotechnological applications.) Yet, advancing interdisciplinary approaches in all of these mentioned fields will turn out to be necessary for and conducive to practical applications in the near future."
(End of passage paraphrased from Lenk et al. (1998))

2 Social traps, Prisoners' Dilemma situations etc. as pertaining to land, soil, and environment

In economics and social science scholars speak of social traps, the externalities problem, side-effects, social costs, the Prisoners' Dilemma, and the public goods problem. I would like to illustrate the problem first by using the problem structure of the so-called *"Tragedy of the Commons"* (Hardin, 1968). This constellation can be understood as a prototype of a social trap. The central question will turn out to be: Who would bear the responsibility for an action result and for the respective consequences which nobody had wanted or intended beforehand?

According to Hardin every owner of stock in the Sahel zone has an individual and perfectly legitimate interest in utilizing and exploiting the common grassland, the so-called "common", which is indeed a collective good. This individual interest is characterized by striving to have as much stock as possible, because the greater one's own stock, the higher is one's social status. All the owners and society in general, however, have a common interest, a real commonality, namely to avoid overgrazing of the commons. This constellation of individual and common interests would lead to the following dilemma: Because hardly anybody has sufficient individual interest to avoid extensive exploitation of the commons for one's own good, everybody will utilize it as extensively as possible. Therefore, overgrazing of the commons would be the necessary result. Consequently, in the last analysis the very satisfaction of the individual interest would be barred or ruined, respectively. Hardin thinks it necessary to have social, i.e. not merely individual, mechanisms of control, in order really to avoid such a dilemma. Socially enforced cooperation, e. g., would be such a controlling mechanism. He emphasized that such "tragedies of the commons" would undermine or at least relativize the well-known traditional theorem of "the invisible hand" after Adam Smith. (The so-called "invisible hand" in terms of the market mechanism would according to the opinion of classical and neoclassical economists result in such a constellation that the consequences (profit or loss, respectively) would be attributed to the responsible agent and that an optimum overall result in terms of an optimal equilibrium and general wealth, i.e., a Pareto optimum would ensue.) According to Hardin the rational maximizing of each individual interest need not, via dynamic market processes, lead to an optimum result and wealth for all. On the contrary, it may lead to depletion, erosion and pollution etc., of the common land. A similar problem with respect to arable land use also leads to depletion, erosion, even devastation of arable land in large parts of Africa: the few remaining trees and shrubs are necessarily used up and/or consumed to satisfy pressing survival interests of individual families. This consumption leads to further expansion of the desert and to an additional deterioration of sustenance and survival conditions of the whole population etc. (With respect to stock and the above mentioned traditional conflict between the individual owners' interests and social needs even the boring of additional wells might indeed aggravate or escalate the conflict constellation and accelerate the ecological problems. This might be a well-known unintended side-effect of political and economic development programs.

A similar effect is the clearing and making arable of tropical rain forests on basically poor soil which might lead to local and regional erosion and depletion of the ecosystem and to a continental or even global change of the climate (cf. the global carbon dioxide plus methane problem and the impending glass house effect of "overheating" the atmosphere as well as the so-called climate crisis).

Again, also the problem of environmental pollution turns out to be of analogical or equivalent structure. The absence of pollution, a public good indeed, is not diminishing or decreasing in size, but instead a *negative quality* is added, namely through the depositing of refuse of many kinds. Again, it seems more profitable, i. e. cheaper, for the agent to do away with garbage on public soil, e. g., to deposit chemical refuse in the Rhine. As a consequence of these public measures external social costs would result. Negative external effects which would amount to a burden for the general society; they can only be avoided or redirected if the taxpayer or everybody pays in money or is suffering in terms of health disadvantages, deterioration of quality of life or aesthetic values of ecosystems and the landscape. Externalities would result from the actions of producers and consumers whenever these agree on actions which would be disadvantageous for the environment (think of the example of the one-way bottles). Therefore, there is also a responsibility of consumers, co-responsibility with respect to the protection of the environment. On different levels of a scaling phenomenon all members of a society would bear a certain responsibility for an acceptable or good and healthy state of their respective society (Kerber, 1988, p. 243). Generally speaking the same structure is to be found with many problems of social constellations that may be dubbed as *social trap constellations*. It would be "profitable" for individuals to infringe social rules and norms as long as (almost) all other members are abiding by them.

A similar structure is to be found in the so-called *Free-Rider Problem* and the assurance problem with respect to providing and maintaining collective and public goods. Both cases lead to *social traps*. The dilemma of environmental protection on a voluntary basis is an intriguing example of this constellation. The free-rider problem is "A barrier to successful collective action or to the production of a public good that arises because all or some individuals attempt to take a free ride on the contribution of others. Non-contributors (would) reason as follows: Either enough others will contribute to achieve the good or they will not, regardless of whether I contribute or not; but if the good is achieved, I will benefit from it even if I don't contribute. Consequently, since contributing is a cost, I should not contribute" (Buchanan, 1985, p. 124).

Likewise, *"the assurance problem"* is "a barrier to successful collective action or to the production of a public good that arises when all or some individuals decide not to contribute to the good in question because they lack adequate assurance that enough others will contribute" (Buchanan, 1985). The provision and maintenance of a collective good is according to Olson (1968) primarily dependent on the magnitude of group membership: The greater a group of participating individuals, the less the chance and opportunity turn out to be for providing and maintaining such a good and the greater is the necessity of compulsion, sanctions etc. with respect to usage and distribution of collective goods. Whereas community norms or mores would still seem satisfactory for reaching a common goal in small groups, this does not apply to large groups. Buchanan called this phenomenon "the large number dilemma" (Vanberg, 1982, p. 137).

The structural problems of social and individual actions, of public goods, and of the commons and social order can easily be illustrated by using the well-known game theoretical model of the so-called *Prisoners' Dilemma (PD)*. A detailed analysis of the PD structure shows that strategic actions of competing self-interested rational agents lead to a result which turns out to be an unintended social consequence putting all participants on a worse level than a cooperative strategy of abiding by social rules would have obtained. PD-constellations cannot be solved on a pure individualistic level.

The above-mentioned dilemmas are at the same time examples of *rationality traps*: the individually rational action strategy leads to collective social irrationality undermining the first one. Under certain conditions, individual rationality can be self-destructive.

A second problem of *distributing responsibility* does not result just from collective corporate action by itself, but only if many people act *under strategic (competitive) conditions*, if negative external, synergistic and/or cumulative effects occur. Indeed,"strategic condition" means that the final result is dependent on the (relatively independent) acting of many individual agents. Synergistic and cumulative effects would only result, if different components have a joint and mutually escalating impact. The individual components might by themselves be (relatively) harmless, but eventually they would result in the deterioration, depletion or even loss of a highly valued common good (think of the example of the continental European forest "dying" from pollution by acid rain and erosion or, recently, micro- or fine dust by urban car traffic etc.).

3 Extended responsibility and eco-liability

The distribution problem of responsibility, e. g., consists in the fact that frequently side-effects cannot be attributed to a single originator and that they usually were/are or even could not be foreseen or predicted. We have two partial problems here: First the question of participatory responsibility with respect to cumulative and synergistic harmful effects and second the question how to responsibly deal with unforeseen or even unpredictable facts or side-effects. The first problem can be called the problem of distributing responsibility under strategic conditions. For instance, is the legal principle of attributing "causality" and responsibility valid in Japan since the case of the Minamata disease according to which the statistically assessed contribution to the common harm by relevant polluters in the vicinity is ascertained, by law, as *the* pertaining causality indeed satisfactory? The burden of proof here lies so to speak on the side of the potential originator, the polluter, who has to prove the harmlessness of his emissions. This reversal of the burden of proof seems to be at least a controllable and operational measure to allow for attribution wherever environmental damages are in question. In these detriments usually land, water and air use or misuse are combined. They can at least be as a rule forestalled or diminished in a controllable way by assigning sanctions. In that respect the Japanese legal principle of attributing causality might foster environmental protection. But there are methodological and legal as well as moral problems connected with such a regulation. First of all, adjacency and the guessing of causality can never be a proof of a causal origin. In addition, the problem is how to distribute or attribute the responsibility in the cases of synergistic and cumulative damages, particularly those with below-threshold-contributions of individual agents. Another problem is how to distinguish between a descriptive assessment of causal origination and the normative attribution of responsibility, between causal responsibility and liability after Hart (1968). How could one possibly distinguish between the causal impact, the descriptive responsibility, i.e. the descriptive attribution of responsibility, and the respective normative attribution of responsibility for contributions – the amount of which is individually ineffective, below the threshold of harmfulness? And how is one to distribute this kind of responsibility in general? Would it not be meaningful to postulate a normative collective responsibility of all pertinent corporations within the respective region in the sense of a joint liability? This would, however, mean a liability of all relevant corporations for the total damages. The impaired parties could sue for damages, claim in court for compensation and/or indemnification from any presumably participating corporation. Does this make sense, if connected with an overall generalization? This regulation, however, would have the advantage of dispensing with the proof of damage in respect of each singular damaging or aggrieving party – as e. g. a respective norm in German Civil law would prescribe. This kind of regulation would, in some way independent of individual case argumentation, interpret all non-collective agents as quasi one corporative agent being liable in total. The internal distribution and compensation within this quasi-group of corporate agents would then be a problem of mutual bargaining of all aggrieving parties.

Notwithstanding these arguments another kind of total liability with respect to product safety and hazards in terms of environmental damages of public goods should be established. It should be noted that there is a European Community agreement as of 1985 with regard to product liability laws. Causal originators of damages would then/now be liable in the sense of a strict liability in tort, whether or not they are really guilty in terms of intent or only negligent. Causal origination would already ascertain descriptive causal action responsibility and with respect to the damage of a good to be protected also normative responsibility for the respective action and its consequences. This form of liability would hopefully be deterrent enough to prevent infringements. If, however, damages would nevertheless occur it would at least not be necessary to prove fault or guiltiness as a presupposition of any claim for compensation.

Is the human being because of the immense power of technical encroachment and feasibility beyond any beforehand imagination and control responsible for much more, so to speak, than (s)he could possibly foresee and literally (intentionally) be normatively responsible for? Should (s)he not take over responsibility for unforeseen or even unforeseeable side-effects of her or his actions with respect to technological and scientific big science projects? But how could one possibly do that? There is no way of really morally being held responsible for something one does not know or could not know. In the sense of causal responsibility (taken descriptively) one can be held responsible in some sense, even if an unintended damage occurs. The question however is, whether one could be held responsible in a normative-moral sense too. The so-called principle of causation if interpreted in a moral and legal sense, would - at least in tendency - adequately design normative responsibility also. One would have to answer for, to make good and to be liable for consequences in the sense of being liable to pay compensation etc. The range and power of action seems to have multiplied to such a degree that anticipation cannot follow quickly enough or pursue all the complex ramifications of impacts, consequences and side-effects in complex interlaced systems. That seems to be an intriguing dilemma of responsibility in our systems technological age impregnated by complex systems interactions and dynamic changes easily transgressing linear thinking and traditional causal disciplinary knowledge. In principle this also pertains to eco-systems and their respective land bases.

Earlier (Lenk et al., 1998, 439f), I dubbed the distribution dilemma regarding the using or enjoying a nature resource or eco-system by different users (e. g. fishermen and anglers, hobby sailors, rowers, swimmers, naturalists etc. taking advantage of a lake) "the Naturalists' Dilemma" or "Enjoyers' Dilemma". By contradistinction to the PD, this situation can be pragmatically tackled and the problems solved by delimitating, dividing and distributing spaces and/or times, certainly, e. g., by mutual agreement.

Technology, technological progress and economic-industrial development in combination with the respective damages for land, clean air and water turn out to be multi-dimensional phenomena asking for interdisciplinary and complex approaches. Multi-perspectivity is the result of an ongoing mutual interaction between diverse realms and actions of many corporate and individual agents. This is leading to a rather great complexity of individual, collective and corporate contributions, different areas and social background factors. The exponential structure of technological development in terms of range, energy, acceleration, interaction feedback phenomena etc. is a familiar insight of traditional sociology of science, technology and economic development. This insight is generally true for any multi-ramified and interlocked socio-technical or social phenomena of development.

With regard to responsibility in general, it is not only corporations and institutions in economics and industry which have to bear responsibility, but also the state and its representative decision makers. Corporate responsibility has to be connected with individual responsibilities of the respective representative decision makers. This is true also for big technology projects, particularly if they are run by the state itself. There should be not only a legal, but also a moral balance of powers in terms of checks and controls similar to the traditional distribution of legal powers between legislature, government and jurisdiction.

The upshot of this in terms of moral responsibility might be formulated like this: The extension of individualistic responsibility is to be combined with the development of a socially proportionate coresponsibility, and with the establishment and analytic as well as institutional elaboration of corporate responsibility and a new sensitivity of moral conscience. Types of responsibility have to be analyzed in a more differentiated way than hitherto (see Lenk, 2007, 2015; Lenk, 2016; Lenk, 2017a,b,c,d). Only in this way we may be able to cope with the most complex structures of causal networks and the far-ranging consequences of human actions and social impacts. Concepts for a more social orientation of responsibility and conscience should be given most attention. Ethics and moral philosophy have to take serious these new systemic challenges by technically multiplied possibilities and impacts of action and system networks. An applied ethics of not only collective, but also of strategic and network actions as well as their consequences would seem to be urgently needed indeed in applied sciences - even in geodesic projects (see, e. g. Heck, 1979; Luo et al., 2014; Lenk et al., 1994).

References

Buchanan, A. (1985): Ethics, Efficiency, and the Market. Ed. by N. J. Totowa.

Bunge, M. (1967): Scientific Research. vol. 1,2. Springer, Berlin, Heidelberg, New York.

Gottl-Ottlililienfeld, F. (1923): Wirtschaft und Technik, Tübingen.

Hardin, G. (1968): The Tragedy of the Commons. *Science* 162:1243–1248.

Hart, H. L. A. (1968): Punishment and Responsibility. 1968.

Heck, B. (1979): Zur lokalen Geoidbestimmung aus terrestrischen Messungen vertikaler Schweregradienten. *Deutsche Geodätische Kommission, Reihe C*, no. 259. Verlag der Bayerischen Akademie der Wissenschaften in Kommission beim Verlag C. H. Beck, Munich, Germany.

Kerber, W. (1988): Sittlich handeln unter dem Zwang ökonomischer Sachzwänge. In: *Wirtschaftswissenschaft und Ethik*. Ed. by H. Hesse. Berlin, pp. 241–258.

Lenk, H. (1993): Interpretationskonstrukte. Suhrkamp-Verlag, Frankfurt/M.

Lenk, H. (2007): Global TechnoScience and Responsibilty. LIT, Berlin.

Lenk, H. (2015): Human-soziale Verantwortung. Projektverlag, Bochum, Freiburg.

Lenk, H. (2017a): Human - Zwischen Ökoethik und Ökonomik. Projektverlag, Bochum, Freiburg.

Lenk, H. (2017b): Schemas in Aktion. Projektverlag, Bochum, Freiburg.

Lenk, H. (2017c): Scheme Dynamics. Projektverlag, Bochum, Freiburg.

Lenk, H. (2017d): Verantwortlichkeit und Verantwortungstypen. In: *Handbuch Verantwortung*. Ed. by L. Heidbrink, C. Langbehn, and J. Loh. Wiesbaden, pp. 57–84.

Lenk, H., Lenk, U., and Grünreich, D. (1998): Interdisciplinarity and Interdisciplinary GIS Approaches in Coastal Zone Management and Floodplain Area Development. In: *Environments by Design 2*. Kingston:UP, pp. 177–203.

Lenk, H. (2016): Methodological Perspectivism and Scheme-Interpretationism in Science and Elsewhere. *Axiomathes / Epistemologia* 26(4):383–399. DOI: 10.1007/s10516-016-9295-1.

Lenk, U., Seitz, K., and Heck, B. (1994): A Datum Defect and Spectral Analysis in Regional Cross-Over Adjustments of Satellite Altimeter Data. In: *Gravity and Geoid. Joint IGC/ICG Symp. Graz 1994. IAG., vol. 113*. Ed. by H. Sünkel and I. Marson. Springer Berlin Heidelberg, pp. 357–365.

Luo, X., Mayer, M., Heck, B., and Awange, J. L. (2014): A realistic and easy-to-implement weighting model for GPS phase observations. *IEEE Transactions on Geosciense and Remote Sensing* 52(10):6110–6118. DOI: 10.1109/TGRS.2013.2294946.

Olson, M. (1968): Die Logik des kollektiven Handelns. 1968.

Vanberg, V. (1982): Markt und Organisation. 1982.