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# “Local-global policy in the context of an environmental crisis: proposition of a systemic analyze of environmental management on a cross-border territory.”

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System (ecosystem, multi agent system, hydrosystem), self referential subsystem. Procedure and concept of action

**Abstracts**

This paper has the purpose to analyze the organization of users of an international and cross-border river basin. Through the example of the management of an ecological crisis affecting the quality of the main river of this territory, we will present the opportunity to transcend self-referential solutions for each use by creating a metasystem understood as a common language between riverside states. The process of building a new metasystem will be defined and its concretization will be exposed in order to enlighten the brake and lever of the implementation of a common policy regarding the quality of water on a transnational territory.

**Introduction**

Combining local and global policy on a cross-border territory demands the building of a procedure (Lascoumes, Le Bourhis, 1998). Morevoer, in the case of environmental issues involving various actors to accept a common system of references guiding the management of common natural resources in the sense of an ecologization of its uses (Mélard, 2008). The example of the Rhine, the International River managed since 1950, offers a good example of how a system of reference based on the bio-physical evaluation of water quality is built. The concept of hydrosystem created in the context of the accidental pollution of the Rhine (1986) acts as a mediation between the riverside states to guide the actions as regards water protection and reinforces the cooperation of the different states involved in its management (at the global level) and the riverside regions (at the local level). The main purpose of this procedure is the acceptance by the actors of a systemic perception of the Rhine. Based on our research, this procedure can be analyzed as the emergence of a common ecological ethical model implemented in a cross-border region. Therefore, we can suggest three hypothesis: 1 - Confronted by a crisis, the environmental ethical model appears as an emergent quality of the river system. 2 – The Rhine anthropo-ecological system is composed of subsystems, each one communicating and exchanging information only in terms of risk. 3 - Ethics plays the role of metasystem, transcending the self-referential subsystems. Through the meeting of two disciplines (sociology and engineering design), an interpretative framework based on a systemic approach is suggested in order to explain the organization of communication and information's process between the various and self-referential subsystems. The main purpose of this communication is to focus on the action of each system in conditioning at last the dissemination and the acceptance of a unique environmental ethics, understood as the recognition of the intrinsic properties of the Rhine river ecosystem, and adapted to the referents of each system involved. In the first part, we will suggest the characterization of Rhine's system properties. In a second part, we will analyze the risk as a notion creating communication between the sub-systems. In order to organize the respectful use of water,

the actors get organized themselves according to their functions as translators, processors or actors' networks. Finally, in the third part we define in what the emergence of risk contributes to determine an environmental ethic, as the emergent quality of the Rhine river and articulating global-to-local policy.

**Description of the Rhine river system**

The system theory (Parsons, Luhmann and Lagadeug) is an interesting approach to analyze the management of pollution after a hazard in building a theoretical model of the reactions and decisions between the various interacting systems. Moreover, this approach combines the analysis of opposite notions: society and nature, whereas they are interdependent and work based on reciprocal interaction.

This analysis is linked to the work on the ESS study (eco-social system) and will be focused on the integrated systems coupling societies and nature (Liu *et al.*, 2007), which allow the definition of ecosystems explicitly based on the actors involved in the management of a specific issue concerning a common and shared ecosystem. In that way, humans are defined as an active component of the ecosystem (Lagadeug Y. Chenorkian R., 2009), (Folke C., 2007).

The Rhine River may be read as a complex system integrating a large variety of interdependent physical and human phenomenon.

*The components of the Rhine river system*

The Rhine river system integrates a large variety of physical and social phenomena interacting and forming a dynamic system, organized, structured, and plugged on different spatio-temporal scales. According to this first presupposition, we identified three subsystems (Ohresser. C. et Al. 2008):

The « ecosystem subsystem « (designed as ESs) is composed of physical, chemical and biological elements of the Rhine River that can be summarized as the river basin. It is composed of various objects (designed as On) for example groundwater, alluvial environment (meadows, forests) and watercourses, and of interactions (designed as Rn).

$$ESs = \{On, Rn\}$$

The « uses subsystem « (designed as USs) is the socio-economic organization linked to the uses of « ecosystem subsystem «. Its main characteristics are the common objective to exploit the first subsystem described (water resource and environment exploitation, leisure uses). It is composed of ecosystemics objects, designed as On (gravel pit, exploited forest, harbor, barrage), of actors, designed as An (contractors, local authorities, residents and users) and of interactions, designed as In. The logical of this subsystem is the use.

However every use is declined in mono-functional subgroups defining their own use linked to the river.

$$USs = \{On, An, In\}$$

The third subsystem is the « regulation subsystem » (RSs). It is defined by the actors designed as An and the interactions between the actors designed as Rn. The purpose is to organize the management of the objects contained in the two subsystems previously described.

This subsystem organizes the system according to its own logic in order to maintain the coherence of its uses with the resource. The subsystem adapts its strategy and produces new rules organizing the uses.

$$RSs = \{An, Rn\}$$

The interactions between these three subsystems are divided according to their logic of exploitation and regulation, but also according to information transmitted between the actors in each subsystem in order to conserve the quality of the functions of the system.

*The effective properties of the system*

The Rhine river system, as every system, is dynamic and "autopoietic" which means that the system defines permanently the frame and limits of its own development and produces adapted functions according to its own referents, to select objects and to develop communication.

The construction of the system is progressive in time and space according to definition of

every subsystem. Subsystem may be built according to a determined goal in the time or space, in the frame of a specific use of the river. For example, the « ecosystem subsystem » evolves in a geological time whereas the « uses subsystem » is linked to an economic development model defined based on gravel mining or hydropower.

The building system evolves in the space: for example « ecosystem subsystem » loses space for « uses subsystem ».

The system is structured by the interaction between the various objects composing the system. Every modification of one of them or one of the interactions, affects the whole line of the system and its relation to the environment.

The system is self-organized, has its own internal organization according to the result of the retroactive interaction between the actors and the relations composing the system.

The system becomes self-referential when it creates its own code, a referent from which it translates information coming from the environment defined as the exteriority of the subsystem.

The system is opened: it has relations and interactions with systems surrounding but always in the limits of its own logic.

As the system is dynamic and auto-organized, it has self-productive and reproductive abilities.

*Communication: the main operation of the system*

Every system functions thanks to an energy. The result of the dissipation of the energy in the system is the activation of the functions and objects composing it. These elements allow the system to function.

We postulate that the main energy of a multi-agent system is information. Indeed, the main aspect is the movement of organization of agents regarding the alteration of their environment and the informative environment emerging, in our case, due to a chemical accident.

Information is a signal sent by a transmitter to a receiver. The understanding of the information by the receiver depends on the encoding function of the transmitter, and on the abilities of the imprinting or code of the receiver (Morin, 2004). Each agent of the subsystem (1.1) understands the information from its own filters. The receiver has its

own understandings mechanisms depending on the auto-referential abilities of the subsystems. According to defined code, information will be treated and translated according to their needs. In this framework, communication is linked to the environment, everything external to each subsystem. The "ecosystem subsystem" is considered as a resource. Its interactions with other subsystems may be unilateral in the sense that it furnishes the necessary resources for the development of others subsystems. Every modification provokes retroactions of the two others subsystems. For example, to take part of the "uses subsystem" of groundwater for agricultural activities modifying the water cycle and thus the recharging groundwater modifying quantity and quality of the water. This modification leads every subsystem to integrate this issue and to modify the relations within the system. Every subsystem communicates on this modification to guarantee its internal development and thus, may control even more the environment.
The Rhine river system is composed of three subsystems generating their own qualities and referents established through the particular relation with other subsystems. From this point the exchange of information is limited to the self-referential ability of each subsystem. The subsystem is thus limited in its functions. It cannot overtake the self referential logics of the « uses subsystem ». In this progressive system, the emerging quality is not the environmental ethic but the production of communication regarding the crisis.

**Transformation of communication in the Rhine river system confronted to an ecological crisis**

After several ecological damages and a main accident happening in November 1st in 1986 the whole users of the Rhine were forced to think their actions on the environment on the basis of the building of a common perception of the Rhine River. From a systemic point of view, this accident is an example of a lack of balance in the system because it disturbs its development opportunities.

*The ecological crisis*

At the beginning of the 1980's, the Rhine was one of the most polluted rivers in Europe:

the whole uses of the riverside countries impacted the quality of the river. Three main impacts were identified : first the wasted waters directly sent in the Rhine, affecting the quality of the river and the alluvial environment and linked ecosystems. This was particularly amplified with the industrial activities set up on the bank and provoking deforestation. Secondly, the canalization of the Rhine cut off watercourses from the Rhine régime but also affected the natural migration of fish. Thirdly, the flood power was accelerated due to the canalization causing damages and deaths for the downstream riverside cities.

It this context of degradation, on November 1st in 1986 a fire broke out in a chemical warehouse in Basel harbor. Approximately 10 000 to 15 000 m3 of water mixed to toxic products were poured in the Rhine. The whole Rhine system was impacted with this pollution – ecosystem and uses.

This visible accident (causing death of several fishes) was the revelation of the fragility of the Rhine and had consequences for the sectional uses. The whole system is not balanced. A subsystem imposes on others:

- the "uses subsystem exploits unilaterally the subsystem ecosystem without feedback or exchange;

- the "regulation subsystem" does not play a role. This accident reveals the limits of the policy of recovery of the quality of the Rhine developed since 1950. Moreover, the first regulation's efforts were not complete regarding the quality of the Rhine waters. The bad values of environmental indicators do not lead to a modification of the practices in "subsystem usage".

Exchange of information between the "ecosystem subsystem" transmitter and the "uses subsystem" receiver has not been efficient, the "uses subsystem" keep its normal functions, without hearing the message coming from the regulator, revealing the fragility of the "ecosystem subsystem". The communication has not been done, the imprints or self-referential codes of each subsystem, affecting the conditions of coding and transcoding. The gradual degradation of the general state of the Rhine, was just the concern of the "regulation subsystem" because the degradation did not affect the

"ecosystem subsystem" by the "uses subsystem" does not create new decisions to improve the fluvial system.

The environmental crisis introduces an element of central analysis of our presentation concerning the notion of risk. The risk results of the encounter of social vulnerability and, in this case, a technological hazard. As soon as the "regulation subsystem" encounters the notion of risk, on the basis of a scientific expertise of the degradation, the "uses subsystem" react because the agents share a common uncertainty regarding the continuity of the fluvial system and thus of their own operations.

*The position of the agents in the fluvial system for the emerging of an environmental ethics.*

Communication on the risk occurred on different levels with different actors and led to various effects.

The information in this context is the motor for the organization of agents for an emerging environmental ethics (Rolland May, 2000). We distinguish three positions of agents according to our model of the Rhine system composed of various subsystems (ecosystem, uses subsystem and regulation). These positions depend on the reception and the translation of information regarding the environmental crisis: the level of actor and the network of agents, the level of the translator and the level of the processor. We aim to enlighten the self-referential adaptations of the "uses subsystem". We will see in what way this articulation of agents leads to the emergence of a common environmental ethics as an emergent quality of the system, moreover in the case of a cross border territory.

*The agent translator: definition of the object of communication generating an ethic.*

The translator is the actor that « *processes the transformation of an event* » (Miller, 1978) : this agent translates the received information for the whole system. This agent is incarnated by a specific agent assuming the coherence of the information on the risk coming from the actions of communication from the processor.

In the case studied, the translation was led by the International Commission for the Protection of the Rhine (ICPR) coming from the "uses subsystem". This commission

becomes the "regulator subsystem" by translating information.

The action of the ICPR corresponds to a « soft law » (Möllenkamp, 2001), based on the adhesion of the actors to general programs of action. On the other hand, the ICPR did not have the function of centralizing information regarding the Rhine. It was thus difficult to aggregate the riverside states around a common reading of the degradation. This difficulty was accentuated by the rivalries between the partners state, France opposing hydropower interests to the German proposition regarding an integrated management of the Rhine. When communication emerged in terms of global and unpredictable risk, the riverside states incorporate in this commission and give the necessary powers of the crisis management to the ICPR, recognizing a centralizing function for the management of the river. The Commission becomes a translator:

- by centralizing the relative knowledge of the "ecosystem subsystem" and by imposing its function of "regulation subsystem";
- by coordinating the actions of subsystem uses of the actors by defining the concept of action, the hydrosystem and the restoration of the environment for the reintroduction of the salmon in the Rhine.

The ICPR is in charge to define an initial state from which the objectives of quality must be negotiated and applied by the "uses subsystem" and transmitted by processors coming from this subsystem.

The ICPR as translator evaluate the risk with the help of experts and define the vulnerability level of the Rhine system. In other words, the ICPR define the limits of the "uses subsystem" and organize communication between the agents around the vulnerability point.

The ICPR as translator aggregate the different imprintings of the agents' network and of the processors on the basis of a selection of information linked to its own imprinting. The translator plays the role of referee by conciliating divergent positions resulting of different imprinting.

The ICPR transducts the concept of hydrosystem as an element including the "ecosystem subsystem" and "uses subsystem". The concept of hydrosystem goes over the notion of risk to create the paths for a change of the practices and outline an environmental ethics of the Rhine system.

*The scale of the processor: concretization of environmental ethics*

The processor is the actor changing the object (Le Moigne, 1994). He gives concrete expression to the actions initiated by the translator or by the agents' network in order to build a common repertory of actions and rules defined as an environmental ethic, as the emerging quality of the system.

The action of the processor refers to the translator who defines the general lines of concrete actions to do. He gets in touch with others agents through partnerships in order to enact the concept of action defined by the translator.

In our case, the processors are the environmental agencies, who regulate modalities of actions and communication with economic agents of the "uses subsystem" and of experts for each state; but also the naturalists and protectors of nature gather through nongovernmental organizations, particularly involved since the first pollution analyzed (in the 60's). These NGO's promote an environmental ethic on the basis of scientific knowledge. They expose projects of deforestation caused by industrialization. In the case of the Upper Rhine, the protests were transnational, on both rivers of the Rhine to promote the concerns of local authorities, populations but also of politics to act to protect a natural patrimony.

*The scale of the agent and the agents' network of each subsystem: the vector of adhesion of the ethic.*

This scale acts like an interface between the changing process and the uses system of the Rhine. This is the scale of emission and reception of information. The objective of these exchanges are :

- To define a point of view regarding the environmental management during and after the environmental crisis.
- To create the adhesion of most of the agents to improve the state of "ecosystem subsystem".

The agents are concerned on both separated level :

- They are directly concerned by environmental values and necessity of action after the ecological accident in Basel;
- They are mobilized against the restrictive consequences of the protection program on their economic activities.

Some of these agents are federated in an associative, political, and economic network. It may be a riverside population association, leisure users of the Rhine and its environment, local authorities, workers contributing to the general improvement of the hydrosystem through a modification of the practices.

This is an essential scale because it feeds the system in upward information but also relays downward information. The process creating the ethic requires the adhesion of a large part of agents to be recognized.

The degradation of the fluvial system stops only when "regulation subsystem" communicates in terms of risk: it determines the limits of vulnerability of the whole system and thus the own limits of each subsystem. This communication permits the emergence of a common referent: the hydrosystem concept as the result of the aggregation of the different imprintings of each agent involved in Rhine protection. The environmental ethic substitutes risk communication. But in which way does the environmental ethic become at a local level, a shared value?

**Articulation of global and local levels: how is the hydrosystem concept translated and concretized**

The communication between the subsystems is established on the concept of hydrosystem after the referee of the aggregated imprintings of the agents (the users of the Rhine system). The ICPR as a translator aims to achieve equilibrium between the "uses subsystem" and the "ecosystem subsystem". The ICPR checks the role of the processor by concretizing the concept. Based on all of these actions a common value is defined as an environmental ethic proper of the Rhine system. By ethic, we define the result of a building process a series of values created by a specific social system based on selected

elements generating practices (uses, construction of regulation dispositive) on local level.

*Environmental ethic as metasystem*

The ethic may be a metasystem conditioning the agents' practices reunited within the system and overstepping imprintings of each respective agent. This ethic acts as a common frame of values and representations making possible the action of the agent and leading to new practices, thereby reformulating the ethic. The action of the ICPR translates, according to a global project, the general improvement and the perpetuation of the state of the Rhine: the localized and individualized actions of agents processing by their actions whatever the subsystem in which they are involved. The translator transfers these parameters to the processing agents. The environmental ethic must be appropriated and integrated into the different imprintings of agents in constant definition of new practices. In order to achieve the common objective of the adhesion of agents to an environmental ethic, a definition must be given. Therefore, the ICPR held this position: all the actions and projects following the implementation of the concept of hydrosystem are led in reference to this concept in order to achieve an appropriation, which means a reception, translation, and adaptation of practices and representations for each actor.

*The appropriation of different sales around the principle of precaution*

The definition of the frame of the environmental ethic by the translator is directly linked to the notion of risk. Serres speaks of the "ethic of the rudder" to define an action based on care and precaution (Serres, 2004). For Ewald, the environmental ethic is based on the precaution principle as « *an attitude of protection towards a vague, uncertain future* », and had the purpose to create an ideal equilibrium between practices and an ecosystem (Ewald, 1996).

After an environmental crisis, a new organization of usage is generated and is the object of the communication between the agents is no longer the risk (as during a time of crisis) but the protection of the hydrosystem defined by the principle of precaution. The message of the translator and the relocation of the environmental ethic, as a concept of action

wanting to build a repertory of values generating social practices for the protection of the "ecoystem subsystem".

We can distinguish in the following table the declination of the environmental ethics by different agents according to three indicators: the values, representations, and practices developed to improve and maintain the quality of the Rhine system. These three factors expressed the level of appropriation as revelatory of the adhesion of agents to the environmental ethic and the use at each level of actors of the "ecosystem subsystem". The levels of actors, despite translator, do not share an environmental ethic, since each level has its own ethic. (Table 1).

Table 1. The ethics linked to the users.

| Scale of agent | Values | Representations | Practices | Imprinting |
|---|---|---|---|---|
| **Translator** | Equilibrium between uses and ecosystem | Hydrosystem | Prescription, incentive, centralization of knowledges reglementation | Law |
| **Processor** | Exploitation of the Rhine | Leak | Development of fluvial transport, technical | Economy |
| **Network of agents** | Non utilitarian use | landscape | Public awareness of the global environment | Leisure |

The environmental ethic is the product of various actions of agents in the process of improving of the Rhine. The environmental ethic is conditioned to being received by each agent. The change of practices consists most largely to the opening of groups of agents carrying a representation closer to the ethic or on the contrary to the reinforcement of closing logics of some agents (agriculture, industry). This position affects the broadcasting and the concretization of the environmental ethic for the whole system and thus, may limit the consequence of the ethic. The unique representation of the ethic and its concrete effects are difficult to grasp.

*Impact of the properties of the Rhine system on the environmental ethic*

In the part 1.2 of this contribution the Rhine system is defined as dynamic and self organized. Its equilibrium is threatened by the environmental crisis and depends on the preservation of the qualities of a certain subsystem and of the relationships in the whole system. Thanks to its communication properties, the Rhine system is able to react through a process based on the risk principle, the principle of precaution and to find a common concept of action. The self-organizational ability of the agents in order to preserve the equilibrium within the whole system depends on the communicative qualities of the Rhine system. The emerging quality, that is to say the environmental ethic is the property of the whole subsystem and the definition of values and action according to a common objective for the agents, allowing the insurance of equilibrium between the subsystems and the reproduction of the global system.

Finally, the environmental ethic is defined as a metasystem, defining the moral for each agent of the system (Morin, 2004), proper to each imprinting: this metasystem acts like a guide of the actions for each agent of the subsystems. The subsystems are unable to encompass an operational action:

In the case of the "ecosystem subsystem", it maintains the exchanges between its various components;

In the case of the "uses subsystem" it exploits the resources of the ecosystem subsystem:

In the case of the "regulation subsystem", it limits the exploitation of the ecosystem subsystem by the uses subsystem and insures the perpetuation of its functions.

The ethic is the emerging quality of each system composed of agents, but its appropriation and its relocation by the different subsystems are different according the level of involvement of the actor.

The aggregation of individual ethics is the environmental ethic proper to the Rhine system. Its constraints are the actions of each level of actors and it consists of a

metasystem carried by the translator. The environmental ethic is thus an abstract value always conditioned by the abilities of definition and adaptation of the global system.

## Conclusion

The environmental ethic is the emerging quality of the Rhine system organized after an environmental crisis. Its construction is possible thanks to the communication established between the different subsystems on the basis of the risk, as a federative and mobilizing notion. The surviving system is translated in each imprinting of the agent. This ethic built on the risk notion endures by mutating in its form and its object based on the axis of communication and the precaution principle. Our model shows the dynamic of the system and, in this way, the fact that the metasystem or environmental ethic is permanently redefined because it depends on the appropriation of the agents of the different subsystems.