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Sustainability and Regional Development

by

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Abstract:

While sustainable development is often viewed as a task for national governments this paper asks what can be done on a regional level. The first part of the paper deals with the general principles of sustainable development according to the concept of the sustainability triangle are explained. It is shown that while economic sustainability prevails during the first stages of the development of a country at a later stage social and environmental sustainability become essential for the mid- and long-term development and stability of an economy.

In the second part it is shown that sustainable development is not a task for central government alone but is also an important challenge for regional governments. Some tasks necessary for a sustainable development like e. g. groundwater protection can even be better executed on a regional level. Therefore, special emphasis will be put on water protection in this part of the paper. In spite of the responsibility to be taken by regional governments the existence of significant spillover effects between regions makes it necessary to coordinate the policy between central government and regional governments as well as between different regional governments in order achieve overall efficient results.

JEL-classification: R1, R5, Q2, Q3, Q5

1. Introduction

The concept of sustainability or sustainable development has become a "hot" topic among politicians as well as citizens over the past two decades. It can be found on the agenda of most national governments today and many international treaties have been concluded laying down the details of transnational cooperation for a sustainable future of our world. The overall concept of sustainability has three main aspects which are described by the so-called sustainability triangle: economic sustainability, social sustainability and environmental sustainability.

Sustainable development is not only an issue on a national or international level but it is also relevant for regional policy makers. Many problems of sustainable development can be solved better if the necessary decisions are made close to the sources of these problems. The practical implementation and enforcement of sustainability policy and the monitoring of people's compliance with the different policy measures have to be allocated to the regional governments. In the context of environmental sustainability regional policy is called for whenever regional pollutants have to be dealt with like in the case of water protection. Sustainable development can be achieved only if it is firmly rooted in the regions and in the minds of the people living there. It is a "bottom - up" and not a "top - down" issue. In this paper the main principles of sustainability are explained and practical measures to ensure sustainable development on a regional level are suggested.

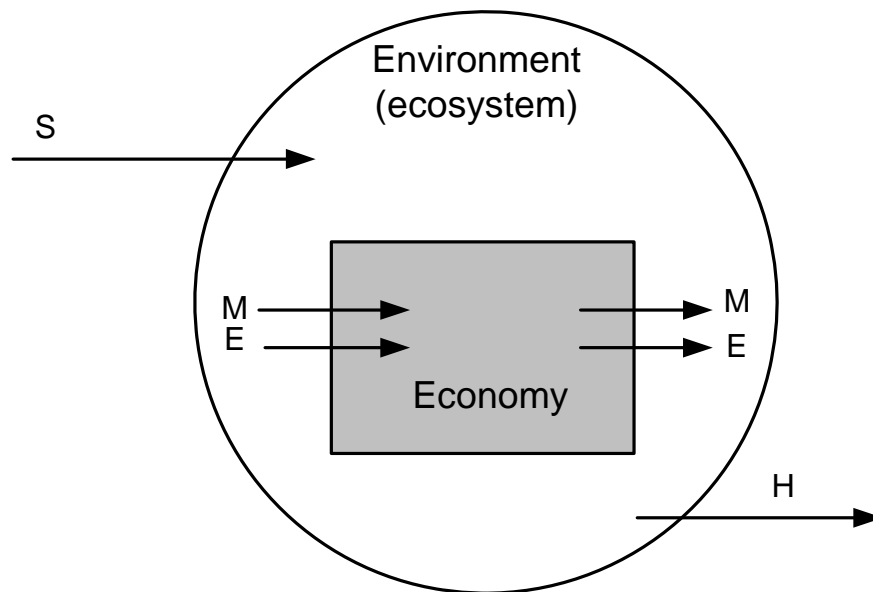
The paper is organized as follows. In the next section the general idea of sustainable development will be elucidated in more detail as a basis for the further discussion, and the different facets of sustainability will be explained. In section 3 it will be asked what can be done for sustainable development on a regional level and a number of different policy measures will be suggested. A special focus in this context will be on water pollution and water protection because regional governments carry a particular responsibility in this field. Section 4 contains some concluding remarks.

2. The concept of sustainability

In the public discussion sustainable development is often identified with environmental preservation. It will be shown, however, that this notion of sustainability is too narrow and that a sound understanding of sustainable development has to include social as well as economic aspects, too.

The general idea of sustainable development can be illustrated very nicely by Herman Daly's (1994) concept of "Spaceship Earth". This metaphor suggests that our earth can be compared to a spaceship gliding through the universe (cf. e. g. Daly 1994, p. 23, or Prugh 1999, p. 20). Our only connection with the outside space is that our earth receives (solar) energy from the sun and emits energy (heat) into the space but no exchange of matter with

the outer space is possible. In physics such a system is called a "closed system" (as distinct from an "isolated system" where neither energy nor matter and an "open system" where both can be exchanged). The fact that our earth is a closed system implies that everything is finite or limited here. It implies also that human life on earth will necessarily come to an end when our natural resources are used up or contaminated or when there is no more room to dump our waste and our emissions. No help can be expected from outside.



S = solar energy; H = heat; M = matter; E = energy

- Fig. 1: Spaceship Earth -

Fig. 1 illustrates what this seclusion means for the relation between the economy and the environment. In the early days of our earth the economy was very small and the environment, i. e. nature, took up most of the space on earth. This state of the world is often described as the "empty world" of our beginnings. As man took possession of the world in the run of time the economy grew faster and faster, thereby pushing back the environment. As the economy grew the environment had to shrink because no expansion of our "spaceship earth" is possible. Every square meter of land that is turned into a road or into a building cannot be a forest or a meadow any more. Therefore, step by step our initially empty world turned into the "full world" we know today.

Sustainability in its broadest sense means that we keep our spaceship intact for future generations. It is, as the so-called Brundtland Report on "Our Common Future" puts it, "Humanity's ability to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs" (*World Commission of Environment and Development 1987, p. 8*). This is in accordance with the so-called Hartwick Rule which

says that the standard of living of people living on earth must not decrease over time until eternity (cf. Hartwick 1977). The concept of "human needs" or "standard of living" is not clearly defined in this special context and, of course, multi-dimensional. Nevertheless, it can be condensed to three main dimensions: an ecological, an economic and a social dimension. These three dimensions are not independent of each other but clearly interrelated in many ways.

In fig. 1 it is shown that inside the "spaceship earth" the economy is embedded in and surrounded by the environment. In terms of physics the economy is an "open system", i. e. it exchanges matter as well as energy with its surroundings: It extracts natural resources from the environment and releases waste and emissions back into the environment. Therefore, the growth of the economy entails exploitation of natural resources and pollution of the environment. In the end it might even mean its total destruction if we are not careful. Environmental protection on the other hand is connected with a diversion of scarce resources from the economic sector to the environmental sector. An area preserved as a national park cannot be utilized at the same time for agriculture and for tourist purposes, resources used for water treatment plants or for emission filters cannot be employed for the production of consumer goods etc. This underlines the fact that there is rivalry between the economy and the environment with respect to the scarce resources of our planet.

On the other hand there are also important synergy effects between the economy and the environment since the environment serves in many ways as a production input in the economy. Therefore, all measures to increase environmental quality also help to increase the efficiency of production processes and thereby the efficiency of the economy. Increasing the cleanness of groundwater reduces the cleaning and filtering cost necessary to use it as drinking water or as an input in the chemical industry; reducing air pollution cuts down the cost of air filtration in e. g. the production of computer chips; increasing water quality in rivers, lakes and the oceans increases the productivity of fishery; reducing the contamination of soil increases the efficiency of agriculture etc. Looking at the tremendous reconstruction costs caused by typhoons, landslides, floods etc. makes clear that climate policy which prevents such natural disasters helps to save economic costs. Another field where the economy benefits from environmental protection is the preservation of biodiversity. Many endangered species might prove to be important inputs e. g. for the pharmaceutical or chemical industry in the future. Their preservation secures the potential for future innovations and thereby supports the future development of the economy. In all these examples the environment and the economy are linked in such a way that every measure that is good for the environment is also good for the economy. Further, one can observe that only countries with a flourishing economy can afford to invest in environmental protection. So, it seems that the health of the economy of a country promotes the health of its environment and vice versa.

From these considerations it becomes obvious that society needs the environment as well as the economy since both contribute to the satisfaction of "human needs". From the economic sector people receive produced consumption goods which contribute to their happiness. The environmental sector contributes to their happiness directly and indirectly: on the one hand the environment represents a direct source of happiness for people who enjoy

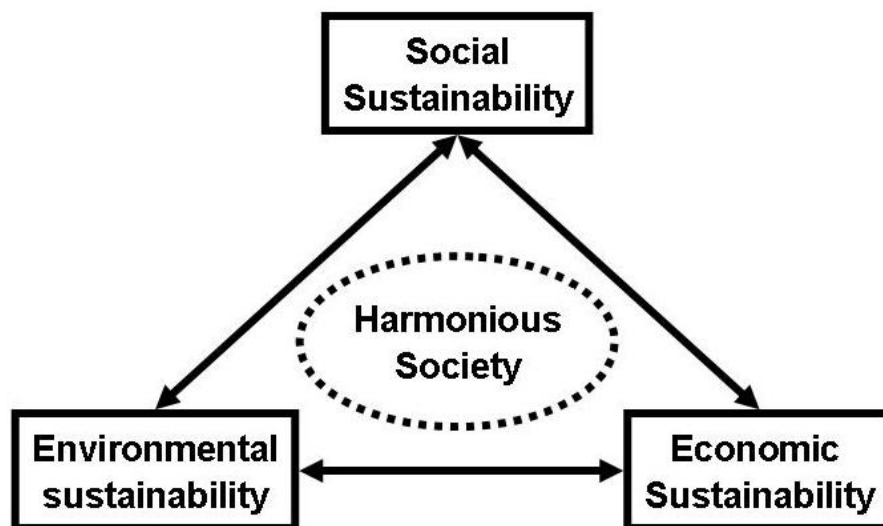
a beautiful landscape, a natural lake, a beach at the sea etc. and on the other hand it provides inputs for the production of consumer goods which make people happy. There is a striking resemblance between the environment and produced capital or human capital. Like the latter two kinds of capital the environment can be viewed as a sort of capital stock from which a steady flow of (direct and indirect) utility goes to society in the course of time. Investment in this capital stock today (i. e. environmental protection, pollution control, laying out of national parks and other conservation areas etc.) leads to an increased flow of utility to society tomorrow. Because of these similarities the environment is often treated as a kind of capital stock in economic theory where one also speaks of "environmental capital" consisting of a multitude of "environmental goods".

The question arises why even societies who do quite well at preserving and increasing their economic capital stock fail completely when it comes to preserving their environmental capital. While economic capital is typically managed and allocated by private markets this is not possible for the environmental capital stock of a society. The reasons for this market failure lie in the specific properties or characteristics of environmental "goods" like air, water, rare species, beautiful landscapes etc. It is extremely difficult or even impossible to define and allocate property rights to such commodities and to exclude people, who do not hold such property rights, from using or consuming these goods. While exclusion of single individuals from the use of many environmental goods (like e. g. the rain forests, fish stocks in the open sea, the atmosphere as a sink for our CO₂ emissions etc.) is impossible or extremely costly the quality or substance of these environmental goods is deteriorated by human use. Such goods are called "common pool goods". One often speaks of the "tragedy of the commons" meaning that common pool goods are doomed because of the fatal combination of "non-excludability" and "rivalry" in use, where the latter means that the quality of these common pool goods decreases as the number of users or the intensity of use increases (cf. Harding 1968). The fact that private markets fail to preserve or enhance the environmental capital stock because of the impossibility to define and allocate effective property rights makes government intervention for its protection necessary.

The third important sector that has to be preserved for future generations because it contributes to the satisfaction of human needs is the social sector. The social sector embraces all social interrelations and interactions and is deeply rooted in the cultures of different societies. Social sustainability aims at fostering and sustaining social interactions and create equitable opportunities for participation in social life where nobody is excluded, discriminated or disadvantaged. Social sustainability embraces the protection of personal freedom and human rights as well as inner and outer peace, social justice and equal opportunities to participate in the material and immaterial wealth of society. Like the environmental sector the social sector depends on government policy for its preservation and enhancement since private markets fail here also.

From these considerations it follows that sustainable development of a society rests on three pillars: economic sustainability, environmental sustainability and social sustainability. This generalized view of sustainability is sometimes called the Three Pillar Model of Sustainability. The fact that the three dimensions of sustainability are closely interrelated is symbolized by

the so-called Sustainability Triangle (fig. 2) which is quite popular in the sustainability debate (for the debate on the Three Pillar Model and the Sustainability Triangle see e. g. Munasinghe 2001, Meadowcroft 2005 or Mauerhofer 2008). It is obvious that the three dimensions of sustainability are equally important for the formation and preservation of a harmonious society.



- Fig. 2: The Sustainability Triangle -

While the Three Pillar Model suggests that the three aspects of sustainability are complementary to each other since they all "work together" for the same overall goal this is not the case all the time simultaneously. Environmental protection typically implies a reduced growth of the economic sector in the short run as compared to a situation where nature is exploited ruthlessly. This describes a relation of rivalry between economic and environmental capital which is relevant especially in the short-term perspective. In long-term perspective things are different: neglecting environmental preservation today leads to reduced economic growth in the future since economic growth depends on an intact environment while, on the other hand, environmental protection is a realistic option only in a society which has already reached a certain minimum level of economic well-being. This describes a complementarity relation between economic and environmental development. That means that we have short-term rivalry and long-term complementarity between these two aspects of sustainability.

Similar relations can be observed between the economic and social well-being of society. Social well-being is often connected with a loss of potential economic growth because it typically implies a redistribution of income and wealth leading to economic disincentives for

the economically successful part of society. Fast and strong economic development on the other hand often leads to an asymmetric distribution of wealth and income and results in social injustice. While these relations describe a certain rivalry between economic and social sustainability it is also clear that economic growth cannot continue for long in an atmosphere of social injustice. Social injustice and the resulting frustration of parts of the population may lead to an actual or impending revolt of the disadvantaged classes. As a consequence an increasing part of the economic resources will have to be diverted from the production of commodities to the protection of the wealthy and the surveillance and suppression of the underprivileged part of the population – a rather inefficient economic situation which cannot be maintained for long. As experience shows after a society has accomplished a certain level of material prosperity it will be able and willing to realize more abstract immaterial values like empathy and social justice which, in turn, will make the economic achievements last. This shows that, like before, there is rivalry in the short run and complementarity in the long run between economic and social sustainability.

Similar bipolar relationships can be identified between social and environmental sustainability. Both are competing for scarce economic resources which have to be diverted from the economic sector and can be used either for social or for environmental sustainability, so that there is rivalry between the two. On the other hand only a stabile society can ensure environmental sustainability instead of overexploitation of natural resources, and a destroyed natural environment will lead to unrests and maybe even wars for the remaining natural resources, e. g. clean water or uncontaminated soil. So, again, we have short-term rivalry and long-term complementarity between environmental and social sustainability.

These considerations show that in the long run all three dimensions or pillars of sustainability are complementary to each other while from a short-term perspective there is rivalry between them because they are competing for the scarce resources of an economy. Since in developing societies typically the short-term perspective dominates the thinking of politicians and citizens it is not surprising that in the course of the development of many countries in the beginning the main focus is on economic development while social and environmental sustainability are more or less neglected. This leads to a massive overuse of the environment and a dramatic deterioration of the quality of life because of the ensuing threats to people's health. At the same time the neglect of social sustainability distorts social equilibrium and leads to social inequality and injustice impairing the stability of society. The resulting problems typically lead societies that have solved their elementary and most pressing economic problems to a more sustainable and balanced path of growth where the three dimensions of sustainability as described by the Sustainability Triangle are kept in equilibrium.

3. Sustainability and regional development

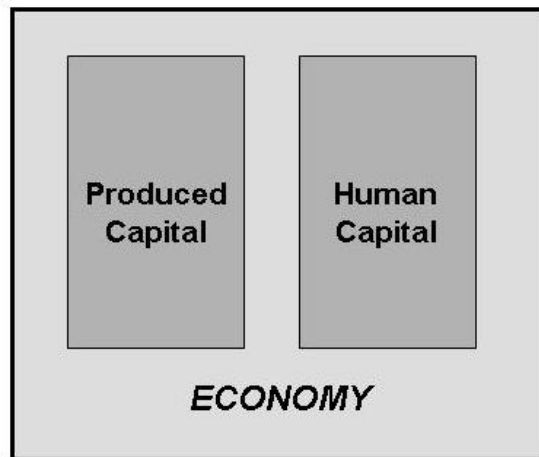
Regional development and the policy measures it requires can be viewed from a national or from a regional perspective. The national or even supranational (cf. the European Union) perspective treats the different regions of a country as equally important and typically aims at improvements of the standard of living in all regions and at a certain equilibrium between them so that no region feels disadvantaged. The regional perspective naturally is dominated by a more competitive view according to which the different regions compete against each other for the scarce resources provided by the central government. Equity or fairness considerations regarding the distribution of wealth between the different regions are important for the policy of central governments but not for regional politicians. This suggests that central government and regional governments might come to different conclusions regarding the best solution to the economic, social and environmental problems to be solved for a sustainable development. Especially, when it has to be decided how the short-term burden (in the sense of a temporarily reduced GNP) of a long-term sustainable development of the whole state have to be shared between the different regions it will be difficult to reach a mutually acceptable and generally accepted consensus.

It is obvious that regional governments should have the last word in deciding on all issues concerning only their specific region, i. e. that have their origin in the respective region and that have no consequences for other regions. But it is also obvious that there are not many political issues that fulfil this precondition for isolated political decisions. Since the sharing of tasks and responsibilities between central government and regional governments is also a question of power sharing it has to be negotiated in a political process between central and regional governments. In the following analysis of regional policies for a sustainable regional development typically the regional perspective will be adopted.

Economic sustainability

As shown in fig. 3 the economic capital of an economy can be subdivided into two main sectors, produced capital and human capital. The stock of produced capital consists of all produced production factors of an economy, i. e. infrastructure, production plants, buildings etc. Human capital embraces the technological and scientific knowledge or knowhow of a society.

Both capital stocks require a permanent flow of investments to replace that part that is used up in the run of time and to enhance both capital stocks if possible. This implies that a significant part of the production factors available today must be diverted from the production of consumption goods to the production of investment goods ("produced capital") and to education as well as to the creation of new knowledge ("human capital"). That means that we cut back our consumption today for the sake of future consumption possibilities resulting from enhanced produced capital and human capital stocks.



- Fig. 3: *The Economic Capital Stock* -

Though the support and stimulation of knowledge creation and the guaranteeing of education is an important task of central governments regional governments can support this process in several ways. Enhancement and development of the **human capital stock** in a region requires e. g. an improvement of the quality of the school system. Such a process can be supported by

- attracting more and better teachers,
- improving teaching materials,
- renovating school buildings and building new schools,
- keeping children's way to school reasonably short und safe,
- establishing bus shuttle services for very young school children,
- establishing a system of boarding schools for children living in remote areas far away from the next school,
- making sure that all children of school age attend school regularly instead of working for their parents at home. This might imply compensation payments to very poor people with children of school age.

Building up the regional human capital stock can also mean to encourage and support the establishment of research institutes and universities in the region. Such institutions can develop new scientific and technological knowledge on the one hand and train future high-skill employees for the regional industries on the other. In order to stimulate the establishment of scientific institutions in a region supporting measures might be helpful like

- providing land for university buildings, housing estates for employees, student dorms and setting up the necessary infrastructure,

- establishing a system of scholarships for students of the regional universities,
- investing in the cultural, social and natural environment in order to make the region more attractive for researchers, students and high potential graduates or employees to make them stay in the region after their education has been accomplished.

Summing up: the region has to provide the technical, economic, social and environmental infrastructure for the development of a scientific community within its borders.

Suitable measures for the stimulation of a sustainable development of the **produced capital stock** are rather well-known and have been broadly discussed in the media since a long time. Therefore they can be treated rather briefly here. Especially important is public investment in the regional infrastructure in order to attract private capital, i. e.

- improving the regional network of roads, highways, railways, making rivers and canals navigable and other measures to facilitate the transportation of goods and people,
- building new airports, implementing new air connections to the economic hot spots of the country,
- improving the public transport system (buses, subways, trains, ferries etc.),
- developing industrial zones in a region where new and matching industries can be established and where synergetic effects between the different industries can be utilized,
- improving the generation and transport / distribution of energy to meet the energy demand of a growing industrial sector etc.

Of course, direct investment of government in state-owned enterprises and production plants is also possible in order to increase the regional capital stock. However, this can be recommended only in very special cases where private suppliers fail to ensure an optimal supply of the goods in question or where important reasons like national security make immediate government monitoring or supervision of production in a certain sector necessary.

Though this overview over possible measures to support economic sustainability on a regional level is certainly incomplete it makes clear that also regional governments can take responsibility here and stimulate important developments in this field.

Social sustainability

Social sustainability is often seen as social stability over time. Among the most important prerequisites of social sustainability are a certain minimum level of life satisfaction for all citizens, faith in the future and harmony between the different groups of society. It is

essential to give people a reliable and positive life perspective for the present as well as for the future and to leave nobody behind. This holds on a national as well as on a regional level.

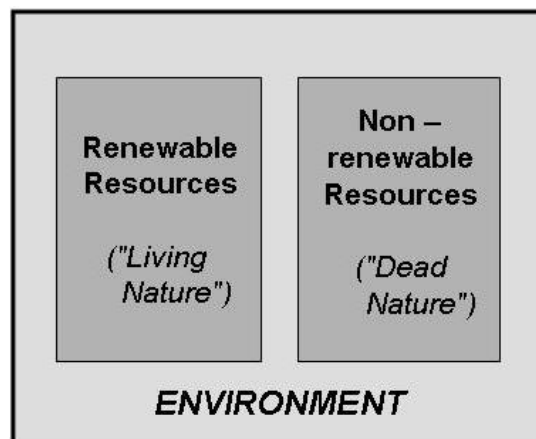
Social sustainability therefore requires that no individual should feel neglected or "forgotten" by society – especially in difficult situations like old age, illness and the impossibility to make a living by one's own efforts. Therefore, it is among other things necessary to establish a functioning social system with a well-balanced social security system, which on the one hand sets incentives for people to support themselves by their own efforts and on the other hand helps those who are unable to do this. Social security also implies a functioning health-care system and a reliable system of unemployment benefits as well as a general pension system. These insurances can be organized by central governments or by regional governments and even by local municipalities, but it should be clear that the idea of risk sharing which is inherent in the concept of any insurance works the better the more people are willing to pool their individual risks. However, in many developing countries these risks are shared only between the members of single families so that there is no tradition of a public social security system at all. In these cases it means already a great progress if a region-wide social security system is provided.

As mentioned before, the long-term aspect of social sustainability implies that society should "give people a future". This requires among other things stability of society as a whole as well as of the economic system so that people can plan their future. This is important in order to create incentives for people to strive for an education to build up their human capital stock and to save money to build up a financial capital stock for their old days. Such incentives can develop only if people can be confident that their human and financial capital will not be devaluated in the future by social unrests or political revolutions. Therefore, political and economic stability are important prerequisites of social sustainability on a national as well as on a regional level. Further, social sustainability implies as a matter of course personal freedom and a well-functioning judicial system as well as social justice, i. e. a distribution of income and wealth which is in accordance with people's sense of fairness and justice. While the accomplishment of most of these requirements is primarily a task of central governments the active cooperation of regional governments is absolutely necessary.

Environmental sustainability

The environmental capital stock consists of two main parts, renewable resources and non-renewable resources (cf. Fig. 4). The stock of renewable resources comprises all plants and animals ("Living Nature"), while non-renewable resources are resources like e. g. minerals, fossil fuels etc. ("Dead Nature"). Transferring an intact environmental capital to future generations requires also to take care of the main environmental media air, water and soil since their condition is decisive for the survival of plants and animals, i. e. the living nature. As a consequence of the anthropocentric view of the world of economics sustainability requires that the environmental capital stock is kept in such a condition "that it meets

the needs of the present without compromising the ability of future generations to meet their own needs" (*World Commission of Environment and Development 1987, p. 8*). This implies that also aesthetic values like e. g. the beauty of a landscape have to be taken into account since they also address "human needs" as used in this definition.



- Fig. 4: The Environmental Capital Stock -

Setting up new industries typically affects the environment in many different ways. Among these environmental effects of industrialization are the pollution of air, water and soil as well as the deterioration of landscape beauty or the loss of biodiversity. Most of these effects are also caused by intensive agricultural production.

Air pollution

It is clear that most measures for environmental protection that are taken on a regional level cannot be designed autonomously, especially in the case of air quality protection. They are typically restricted by national and even supranational regulations, i. e. regional measures for environmental protection must be designed such that they do not contradict national or international law (cf. Oates 1999 for a comprehensive treatment of the general problem of task sharing between central and regional governments and Adler 1998 or Garcia-Valinas 2004 for the environmental policy perspective). Further, an efficient regional policy for environmental protection must be coordinated with neighboring regions because of the spillover effects that are typical for many kinds of environmental pollution. Air pollution in one region often affects air quality in other regions, but also water pollution does not always stop at the political border of one region, since water pollutants are often carried away by the

currents of streams, rivers and also of the groundwater. Therefore, regulations for the protection of air and water quality are often coordinated by a suitable regulatory framework designed by a central government.

Nevertheless, much can be done also on a regional level. The most important task will be to make sure that firms and households do not emit more pollutants than the law permits them. On a regional level this kind of command and control policy is very popular and also effective. Effectiveness of command and control policy, of course, requires strict controls and high fines for those who violate the legal regulations, i. e. for those firms (or households) whose noxious emissions exceed the legal threshold values. As is well-known, the so-called market instruments of environmental policy like emission taxes and emission trading are economically more efficient in the sense of static as well as dynamic efficiency than regulatory policy. They make sure that marginal abatement costs of all polluters are equated over the whole region (static efficiency) and set permanent incentives for research and development of new and better abatement technologies (dynamic efficiency). Therefore, if emission fees or taxes are feasible for regional governments under the prevailing political and legal circumstances this is, of course, an effective and economically efficient way of cutting back air pollution (cf. e. g. Ahlheim 1999). In many countries, however, such taxes can be imposed only by the central government. In cases with significant spillover effects from one region to the other national regulations are, of course, more efficient than regional solutions.

Nevertheless, for mainly regional air pollutants like e. g. sulfur dioxide (SO_2), nitrogen oxides (NO_x), ozone or particulates local solutions can be appropriate. For example emissions of SO_2 lead to the so-called "acid rain" problem which means that acid substances leache out of SO_2 -polluted air when it rains so that lakes, rivers and soil are polluted by the sulfuric acid that is created by the chemical reaction of SO_2 and water. This leads to severe damages to forests and other plants. Environmental policy solutions to this regional kind of pollution problems can be found on a regional level if no transboundary pollution has to be expected (for a comprehensive treatment of the problem of regional pollutants see e. g. Tietenberg 2006, p. 395-421). Such solutions can be regional pollution taxes and also regional emission trading systems. Emission trading means that polluters have to buy emission permits or certificates for every ton of a pollutant like SO_2 they want to discharge. Emission trading sets the same kind of incentives to reduce emissions like emission taxes since they attach a certain price to every ton of a pollutant discharged. In contrast to taxes they also limit the overall emission quantity that is tolerated in a certain region since overall emissions are limited by the number of emission permits (for details of emission trading see e. g. Field / Field 2006, p. 257 ff. or Ahlheim / Schneider 2002). A problem with regional emission trading systems is that the permit markets may be too "thin", e. g. there might be too few market participants so that no efficient market prices (i. e. prices that reflect the marginal abatement costs of polluters) can form. Instead market price formation is subject to strategic actions of the market actors which leads to inefficient abatement solutions.

A prominent example of a regional emissions trading system that played a pioneer role in its time was the so-called Regional Clean Air Incentives Market (RECLAIM) in California. It was

the first trading program in the U.S. created to reduce urban air pollution. Adopted in October 1993, RECLAIM was enacted to help meet the state and federal ambient air quality standards in the Los Angeles Basin, which at this point in time suffered some of the worst air pollution in the country. The program established an emission permit trade system to reduce emissions of nitrogen oxides (NO_x) by 75 percent and sulfur dioxide (SO₂) by approximately 60 percent by 2003 as compared to the base year 1994 (for details see e. g. Lents / Leyden 1996 or Schwarze / Zapfel 2000). In the end RECLAIM was successful in reducing emissions but the reduction took much longer than expected and the economic efficiency of the program was impaired by the fact that some of the major emitters of NO_x and SO₂ like energy producers were removed from the market after the California energy crisis in 2000. This destroyed one of the major advantages of emission trading, i. e. the equalization of marginal abatement costs over all emitters. Nevertheless, this example shows that also on a regional level policy instruments that were originally designed for large areas can be applied successfully.

Water and soil pollution

In general, the protection of water and soil is more of a task for regional governments than clean air policy. Therefore, we shall deal with this problem in more detail here. Of course, coordination of regional and national policy is also necessary in the case of water quality protection. The need for coordination depends on the geographic dimensions of the respective region and on the question if there are any transboundary effects of water pollution. In the latter case an autonomous water protection policy of one region does not lead to ecologically and economically efficient results. Instead a coordination of regional water protection policies and joint action of several regional governments are necessary.

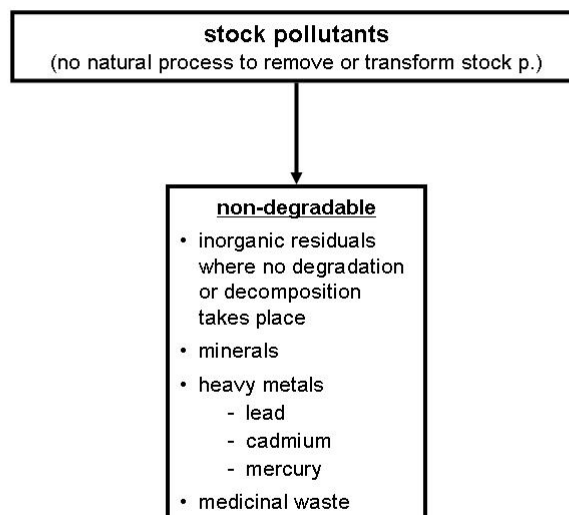
Soil and water pollution are closely related to each other. Contaminated surface water seeping into the ground contaminates the soil (if the soil filters out parts of the solid pollutants contained in the water) while on the other hand noxious particles in the soil might leach into the groundwater.¹ Government policy for the protection of surface water is therefore also a policy for the protection of soil (and of groundwater) while, on the other hand, the protection of the soil from pollution with noxious particles etc. also protects the ground water. Soil and water protection can, therefore, be dealt with jointly in this section.

Contamination of soil and water is harmful to humans in many ways and their protection is essential for the sustainable development of a region. Toxic substances in the surface water like rivers or lakes and in the groundwater influence human wellbeing in many different ways. They affect human health since they are diffused all over the eco-system but they may also impair aesthetic values of a landscape for example if they lead to a eutrophication of lakes

¹ For an extensive discussion of the water protection problem see Tietenberg 2006, p. 446 ff.

and rivers. Toxic substances in the water are taken in by humans directly with the drinking water and indirectly with the food, since they are contained in agricultural products like fruit, vegetables and cereal products but also in meat and in fish. Therefore, clean water policy is an important task of regional policy for the sustainable development of a region.

The huge number of different water pollutants are typically subdivided into two main classes: fund pollutants for which the environment has some assimilative capacity and stock pollutants for which no such capacity exists. The latter are inorganic substances like minerals, heavy metals (lead, mercury, cadmium) and also medicinal residues for which no natural process of degradation or decomposition exists (cf. fig. 5). As a consequence they accumulate in the eco-system in their original form and are diffused by surface water, ground water and by organisms taking them up (i. e. with drinking water). Because of this migration of stock pollutants it is often very difficult to trace them back to the source where they were originally discharged. This is a severe problem for their regulation by government because the application of the "polluter pays" principle of environmental policy is difficult if the polluter is unknown.

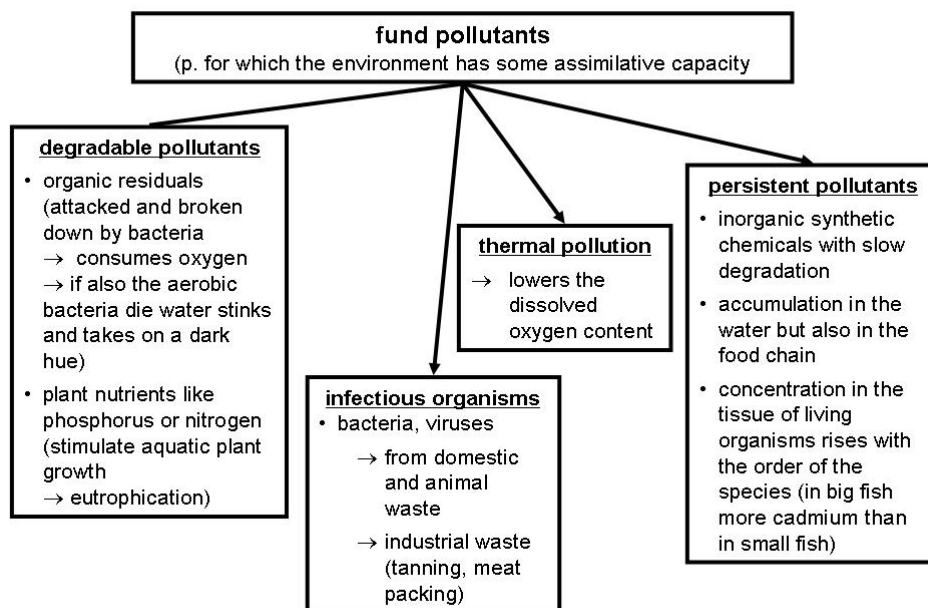


- Fig. 5: Stock Pollutants -

Fund pollutants (cf. fig. 6) can be assimilated by nature to differing degrees. Easily degradable are organic residues which are broken down into their component parts by bacteria in the water. This process typically consumes oxygen that is dissolved in the water so that the oxygen content of the water is reduced by organic waste leading to an increase in fish mortality. In extreme cases the oxygen content in the water drops until even the aerobic bacteria die and the lake becomes anaerobic. It then takes on a dark color and starts to stink

so that the aesthetic value of the lake or river and maybe of the whole landscape is severely impaired. Other degradable pollutants are plant nutrients like phosphorus and nitrogen which lead to an excessive growth of algae and water weeds and also have a negative effect on the aesthetic value of a lake or stream.

Most inorganic chemical residues are more persistent than organic substances but some of them, especially some synthetic chemical substances, are still decomposable by natural processes, although this takes a lot of time. Therefore these pollutants are subject to extensive diffusion in the ecosystem and can be traced back only with difficulties to their origins. They accumulate in the ecosystem over a long time and can be found at all stages of the food chain (cf. e. g. Tietenberg 2006, p. 452). Their regulation by government according to the "polluter pays" principle poses the same problems as the regulation of stock pollutants. Last but not least, infectious residues like bacteria and viruses from human and animal waste as well as organic industrial waste from tanning or meat processing have to be mentioned as hazardous water pollutants which must not be underestimated.

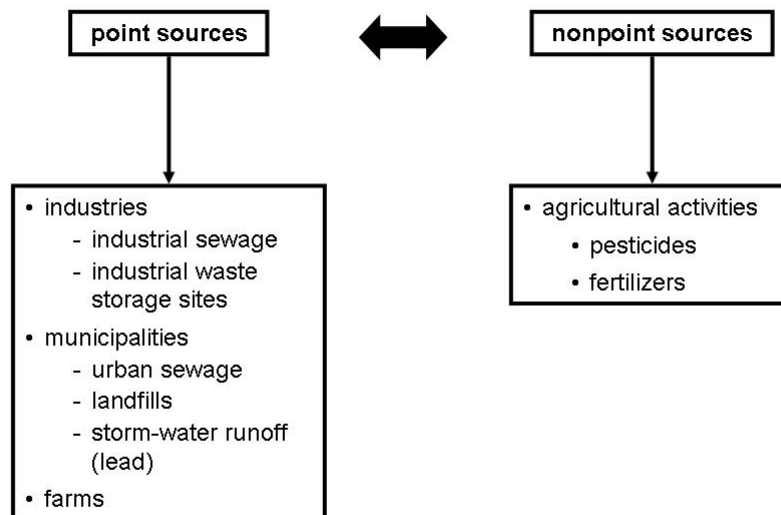


- Fig. 6: Fund Pollutants -

An effective water protection policy on a regional level will combine regulatory ("command & control") instruments of environmental policy on the one hand with market instruments like sewage fees on the other. Political regulation in this field is relatively straightforward as long as the pollutants in question are discharged from a so-called point source like industrial

production plants, municipalities or farms since the polluters can be identified in these cases rather easily (cf. fig. 7). Things become more complicated if we have to deal with pollutants like fertilizers or pesticides that stem from so-called nonpoint sources.

Sustainable water protection policy entails on the one hand measures to reduce the effluent quantity of waste water and on the other hand measures to clean waste water before it is discharged into the environment (rivers, lakes etc.). Since waste water treatment plants show significant economies of scale it does not make sense to force each polluter to clean her or his own sewage individually (as is typical for clean air policy where polluters are forced to clean their waste air by installing filters, catalytic converters etc.). In the case of water protection it is much more efficient if municipalities build large treatment plants and communal sewer networks to which households and smaller firms must be connected. Big industrial firms with hazardous special waste, of course, have to operate their own waste water treatment plants.



- Fig. 7: Sources of Water Pollution -

The cleaner the water that is discharged into public waterways after treatment the higher are the treatment costs for the firms. In order to set incentives for firms to make sufficient efforts to clean their sewage it is important to accompany the legal obligation for firms to treat their waste water by the imposition of a waste water fee where the per-ton amount to be paid increases with the degree of contamination of the waste water discharged after treatment. Additionally, certain minimum standards for waste water quality before discharge have to be defined and enforced to protect the environment since fees alone are not sufficient to make sure that such minimum quality standards are respected.

Aesthetic values

Besides the protection of the "big three" media air, water and soil environmental sustainability also comprises the preservation of aesthetic values like e. g. the beauty of a landscape. Such aesthetic values are often impaired by environmental destruction, for example if a landscape that had previously served mainly for agricultural production is converted into an industrial area. This can lead to important losses of social welfare for the local population (cf. e. g. Ahlheim / Frör 2003). Since aesthetic values affect human wellbeing they are also part of the "human needs" addressed in the Brundtland definition of sustainability. Therefore their protection and preservation for future generations cannot be left out in the context of any policy aiming at sustainable development. Changes of land use are, of course, not possible without changes of the landscape but sustainability in the sense of the Brundtland Report requires that these changes do not lead to a deterioration of landscape beauty in the eyes of the population.

4. Concluding remarks

While sustainable development is often viewed as a task for national governments this paper tries to answer the question what can be done on a regional level. After explaining the general idea of sustainability the Three Pillars of Sustainability were introduced: economic sustainability, social sustainability and environmental sustainability. It was shown that in the long run these three aspects of sustainability, that are often represented in the form of the so-called Sustainability Triangle, are equally important for the development of a society. During the process of development, however, economic aspects typically dominate the thinking of politicians and of citizens in the first phase while social and environmental aspects follow with a certain time lag.

Regarding the division of labor between central and regional governments it was shown that sustainable development cannot be left to central government alone but is also an important task for regional governments. Some tasks necessary for a sustainable development like e. g. groundwater protection can even be better accomplished on a regional level. Because of the existence of significant spillover effects between regions it is important that the policy of central government and regional governments as well as between regional governments is coordinated in order achieve overall efficient results.

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