

The ISIS-model: Information Society – Integrated Systems Model

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ABSTRACT: *The ISIS-model allows a better understanding for managers and regional authorities of the ongoing change towards the information based “New Economy” and towards an information society. New policies have become possible for generating sustainable regional growth, sustainable in both, regional economic success and ecological health. The ISIS-model is build for evaluating policies for sustainability in this holistic setting, as advanced by Naveh and Lieberman 1994. The model also allows to test possible coalitions between the population of a region, the regional economy and the regional nature environment. In this context the model explains and evaluates crucial links between the sectors Information Potential as a main driving power, know-how, New Key People which are behind the present transformation, mature economy, New Economy, land use and quality of life. The model is based on results and applications from several projects, in particular in the EU-project MOSES (Modelling Sustainable Regional Evolution in the Information Society) with partners from Israel, Great Britain, Spain, Austria, Switzerland and Germany .*

Keywords: Information society, new economy, environment, sustainability, dynamic model

INTRODUCTION

The ISIS-model is a regional model. It has two aims: 1) Provide a frame for orientation in a new situation – the emergence of the information society and of the New Economy (For the new economy, see for example Kelly 1998, Tapscott 1998, Hagel et al. 1997, Margherio et al. 1998 and Pine and Gilmore 1999). For many people this is strange and frightening; words like Globalisation capture some of the feelings. Orientation allows to act more successfully and it decreases anxiety. Highly important in the new economy are social networks and mutually beneficial interactions. Socially these are highly welcome. The ISIS-model allows to understand the functioning of such networks. 2) Decision makers often know correctly which actions are more promising but analysis with the ISIS-model showed how isolated actions tend to fail; they need complementary, additional actions. The ISIS-model allows to elaborate bundels of complementary actions.

In this way the ISIS-model allows to analyse “pathways through successive bottlenecks” for better informed and more successful decision-making. The “25 Key Conditions” (Figure 1) describe conditions which a region has to meet to become successful. They are a set of predefined policy options which can be activated to a differing degree. They can also be neglected.

The ISIS-model depicts the development of the “New”, information based economy – depending on policies or autonomous without policies – as well as the development of the mature economy and the driving force behind the new economy, the information potential. This information potential is the sum of capabilities due to large amounts of information and extensive computer networks, globally as well as locally. The model also shows the people who build this information potential and who are behind the new economy. These people understand and know the new possibilities. There is a severe lack of such people as these new skills are usually not yet well taught at universities; most teachers in school do not know much about such things. There is now an effort in many countries to train the teachers. Before this can be done the trainers of the teachers and their superiors have to be trained (the author acts as trainer to leading people in education and management). There is now a global competition to hire people who are knowledgeable in the new field. Even Germany, which used to be very

restrictive with immigration, is now offering Green Cards to knowledgeable people. Here we name such people “New Key People”, as they are key to economic development of the new economy. Based on economic development and a regional population model the ISIS-model also projects employment numbers and unemployed.

Additionally, the model allows to evaluate effects of land use planning, and land use change due to economic and social developments.

For the creation of the new economy manifold new regional requirements must be met, e.g. availability of venture capital or of new key people. These requirements are policy options in the ISIS-model; underlying the model is a set of 25 key issues for creative regional development. More policy options can easily be defined to develop a region well.

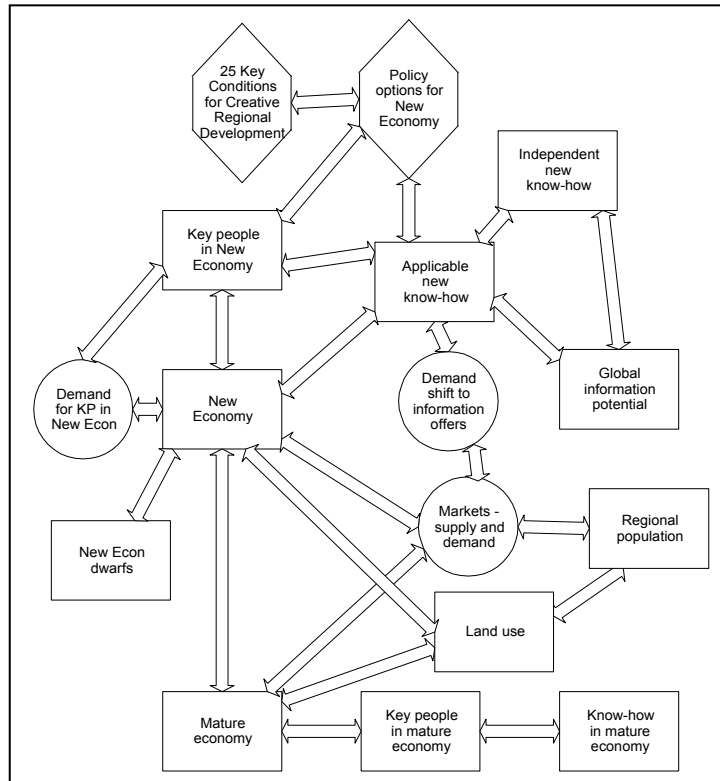


Figure 1: Overall structure of the ISIS-Model

The ISIS-model depicts cross-catalytical relationships wherever these exist or are possible between new key people, the economy and know-how, see below. This was done based on an analysis of about 40 highly successful companies, regions and innovations. All of them are structured as cross-catalytical network (CCN).

The ISIS-model has a fairly general validity. This conclusion is based on extensive groundwork. In the EU-Project MOSES we evaluated the model in six very different regions in Israel, Spain, United Kingdom, Switzerland, Germany and Austria. We worked with scientists from Mendoza, Argentina, on their region and with scientists and planners in several Asian countries in seminars in Thailand and Indonesia and on a variety of Mediterranean countries in several seminars in the IHEAM in Zaragoza, Spain. The new information potential is globally available and it is one of the basic driving forces of economic and social change.

The results from working with the model are translated into plausible graphics for consultation and training. Most decision makers do not look at details of the logic behind conclusions. They want material which allows them to understand the reasoning in a simple way and they want this material in such a way that they themselves can explain any decisions to their auditory. Other people are also grateful if they get attractive material; for example most of the material is used to train leading managers and trainers from DEKRA-Academy which has 110,000 participants per year in its seminars.

The Information Potential

The information potential is a major driving force in the present transition. It includes telecommunication, information, multimedia, entertainment and service. It grows with the number and speed of computers and microprocessors, size and speed of computer networks, amount and quality of computer programs, number of people who know how to apply this new potential and the information that is available in these computer

networks. The ISIS-model combines so-called “laws” (like Moore’s Law) on the development of these components of the information potential with the exception of key people as these do not obey laws with respect to their preferences and numbers.

According to “Metcalf’s Law” the gain in any component, e.g. cellular phones, grows with the square of the number of participants. A growth in the number of participants means an extension of the networks. This needs a parallel increase in the speed of the networks. Based on this reasoning we calculate the information potential as the product of the performance of all its components. In this formula the square law of Metcalfe becomes more general. Since 1970 the information potential has grown by a factor of 1042 and continues to grow. This growth is much faster than can be adapted by society and economy. Therefore nearly nothing of this potential is used, society will need decades to learn how to use what is possible already now and people will continue to think during the next 20 years: “O, there has been a dramatic change in the last two years”. Computer simulations of the information potential show a dramatic jump in each final two years for any period, whether it is from 1970 to 1996 or from 1970 to 2002.

Seven phases of development

Major changes such as the transition to the information society happen through so-called basic innovations. One historic example of a basic innovation is the steam engine which has made coal-mining much easier and thus has helped to overcome the scarcity of energy; the transition from the agricultural to the industrial society began. Energy had been used before (mainly wood), but coal has overcome a bottleneck in availability of energy. Basic innovations in this century were the car, air traffic, telephone, radio and TV. Most of these became powerful in the 1930s. Basic innovations emerge and decline in patterns of about 60 years (two generations). They increase human reach, change people’s perception of what they can do and cause a far reaching transformation of the environment. The present group of new basic innovations involves the information potential.

The evolution of basic innovations happens in very different phases; consultation describes between four to eight. The ISIS-model describes seven phases on changes of the economic, knowledge, social and environmental realms (including land use); Figure 2 depicts these phases for the economy. The duration of each of the phases 2 to 7 is between 5 to 9 years whereas the duration of phase 1 (invention) is not predictable. The ISIS-model describes both, the mature and the new economy, in their phases of development. Historically, there is an overlap between both economies. The mature economy has been in phases 2 to 3 in the 1930s and is now in phases 6, 7 and beyond; the new economy is at present varying between phases 2 to 4, a few new companies are in phase 5.

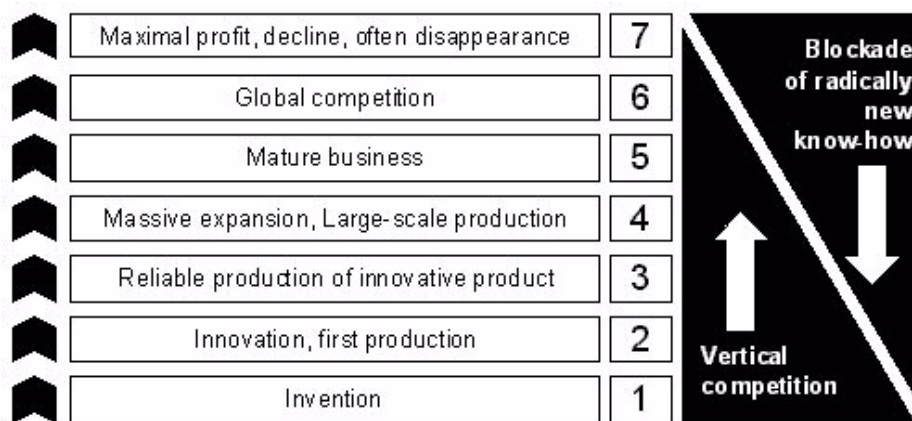


Figure 2: Economic phases of a basic innovation

1. Invention (phase economy 1, e1). There are always numerous inventions. Almost all are useless, but sometimes one changes human life. Some inventions are dormant for a long time.

2. Innovation (phase e2). Innovation is converting an invention into something marketable, desirable and useful. This is a magical process.

3. Pioneering adaptation (phase e3). A promising innovation can grow to its potential only if the outside world is adapted to it and if it is adapted to the world. The microcomputer needs software, experts and courses. The car needs roads, gas stations and driving schools. Each basic innovation needs lots of other inventions and innovations. Therefore, basic innovations come in bundles.

4. Dramatic expansion (phase e4). Phase 3 fulfils all preconditions for a wide expansion of the basic innovation. Afterwards it can expand dramatically, phase 4. Growth in turnover in each of the phases 2, 3 and 4 can be by a factor of 100. Thus, a highly successful company can grow from a few 100,000 \$ in phase 2 to, say, 10 or 20 million \$ in phase 3 to, say, 1 or 2 billion \$ in phase 4. This growth in phase 4 seems dramatic.

5. Convenient life (phase e5): After it became globally visible in phase 4, the expansion usually slows down. Life is very convenient in phase 5, because products are well known, production is smooth, jobs are plenty, staff members are well trained. Regions which supported the upswing of a new basic innovation usually enjoy a very high regional income. This income makes successful regions even more attractive, for example by spending in arts, culture and regional amenities such as sport facilities.

6. Tough global competition (phase e6). Know-how about the basic innovation becomes globally available, production begins everywhere. This starts wide competition. Companies can only survive if they rationalise for cheaper production. Companies are merged and become very big, most companies disappear, many people loose their job and overall qualification can be lower. Average salaries decline, regional income shrinks. Defense against all disturbing factors is strong. One threatening factor is new innovations. They are suppressed in the way which most of us can easily recall from the last few years, e.g. the fight against the Internet by Microsoft, Time Magazine or many states (Microsoft established its own MS Network; Time Magazine printed a falsification on sex in the Internet and many states still prevent their citizens from use of the Internet or censor it). This defense is strongest in regions which want to preserve their mature economy. Therefore, usually, really new things do not develop well in regions which are good and strong in the mature basic innovation. There are exceptions; Berlin managed twice to go with a new basic innovation, the Boston area succeeded three times (Hall and Preston 1988).

7. Sclerotic saturated phase e7: Regions which used to prosper from the basic innovation get poorer as general income in such regions declines. Their basic innovation may disappear entirely, like Atlantic passenger ships due to airplanes, are it may become economically unimportant, like electrical motors which are nearly omnipresent but generate very little regional wealth as they are cheap and competition persists. Laepple (TU Hamburg-Harburg) named this and later phases the “sclerotic milieu”. Later phases often live through subsidies.

Transition from mature to New economy

We are experiencing the end of the industrial era, Figure 3. Beginning in the 1990s the new economy became very big and will overtake the mature economy in most regions after year 2000. The model evaluation shows the value of the companies, not investment, because the value is more easily accessible from the notations at the stock markets. Production in the mature economy will continue to grow even beyond year 2010, although the value of the companies declines. These model evaluations are realistic; established companies, e.g. ABB or Ford/USA already earn more than 50% of their profits with information products. Transport and logistics are refined with extensive use of information. Experts forecast that 90% of profits in logistics will come from use of information, only 10% from the physical transport of goods. Industrial goods, according to consulting company Arthur Andersen, will be produced somewhere in the world, where it is most suitable or where the production happens to stay by some random events. Most money will be earned with information intensive products. In the U.S., 80% of all new jobs are created in small innovative companies that start from scratch. Therefore young firms are important which are able to grow fast while the old industry loses its relevance, Figure 4.

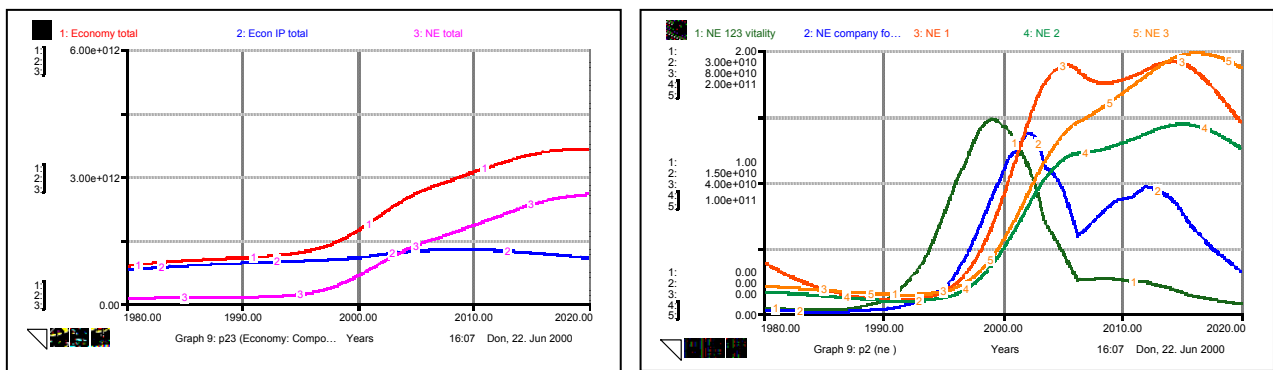


Figure 3 (left): Development of the total economy (curve1), mature economy (curve2) and new economy (curve3)

Figure 4 (right): Conditions for company formation (curve 1), company formation (curve 2), phases 1, 2 and 3 (curves 3, 4 and 5)

The information potential is globally available. It depends on regional factors whether a region benefits from this new potential. The key factors are summarized into the variable “new economy 1,2,3 vitality”, curve 1 in Figure 4. High viability triggers extensive company formation, curve 2 leading to an increase of young companies in phases 1, 2 and 3 (curves 3, 4 and 5, respectively). Moreover, these companies grow and support each other, an auto- and crosscatalytical process.

The next model run evaluates the importance of new key people. Figure 5 depicts two model runs for the city of Hamburg, Germany. The first model run, curve 1, is for the present situation. In the second model run, curve 2, the assumption is that 50,000 new key people will immigrate or be trained beginning in 2001 within one year. 50,000 is 5% of the total workforce. The effect is dramatic growth in company formation which after year 2003 levels off. Many new key people leave, because in the first years they do not have a good income as founders of young companies and therefore cannot get adequate housing in the city of Hamburg. Their quality of life declines rapidly from 10 to 0.1, Figure 6. An average city has a quality of life of 1 which implies that immigration is equal to outmigration; due to the high attractiveness of the city of Hamburg with respect to quality of life the figure is 10 in the beginning. Other new key people move into later phases and are therefore no longer depicted by curve 2.

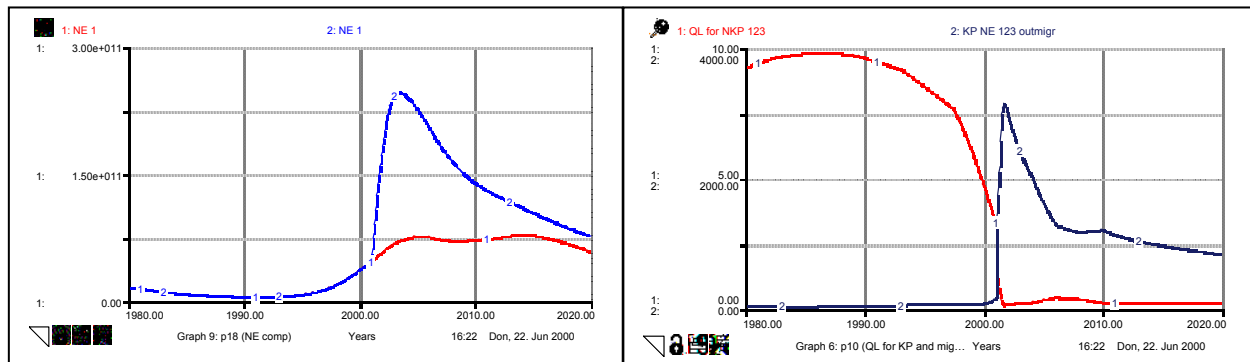


Figure 5 (left): Young companies, phase 1, at present availability of new key people (curve 1) and with an increase of new key people by 50,000 (5% of workforce), curve 2.

Figure 6 (right): Dramatic decrease of quality of life for new key people due to lack of housing

Growth of the new economy can be hyperbolic if availability of these new key people is high, like in Silicon Valley or in Seattle. This high importance of new key people is emphasised by almost all leading managers in this new economy. For example, John Doerr, who speaks for this economy in the U.S, said: “The biggest limitation on new economy growth is finding talented, knowledgeable workers....” (Doerr 1998). Another author says: “People are the crown jewels of this new economy and they know it.”

This lack of new key people has considerable repercussions for availability of jobs in general: each key person creates about 5 additional job, which is an outcome of the normal span of 1 : 5 of leading people to general staff. Therefore it is important to look more closely at this group: what are their regional preferences, which region is more attractive for this group of people? Such evaluations have been done with the ISIS-model. One particular result is the bridges to the environment, section 5.

The results on the dramatic impact of availability of housing were not what we expected in the MOSES-project. We thought that new key people earn enough money so that they can easily pay high rents. This is usually, but not always, true if they are employees, it is wrong when they are forming their own companies. As the new economy comes mainly from the formation of new companies, this bottleneck is severe. Therefore, one possibility to overcoming the lack of new key people is to offer them housing subject to the condition that they start businesses.

Bridges to the environment

The new economy offers several new bridges to the environment. These will be discussed only with respect to land use. People, who earn their money with sophisticated use of information, are naturally highly demanding with respect to their environment. A rich, attractive environment, both build and natural, is an essential “fuel” for them. Also, they can afford to be demanding, beginning with the end of phase 3 (but not in the crucial first phases). The California Economic Strategy Panel (1999) emphasizes several times in its brochure on Californian strategy: “Quality of life for employees is the main reason companies are here”. Similar insights are underlying the design of the new Malaysian Cybercities. There the international planning group for these cities has devised the concept of “Urban Nature Sanctuaries”: “Business civilises the world, while nature heals and inspires. Place them together for work and play and watch a bonding of creativity and innovation: Intelligent City in a Nature Sanctuary. Cyberjaya was conceived as Malaysia's first multimedia city created in a strategic, privileged location and enjoying advanced infrastructure within an eco-friendly environment” (<http://www.cyberjaya-msc.com/cyberjaya/bck-ground.html>) The planners use the insight that wilderness is much more attractive for these people than urban parks with grass. Such semi-natural ecological areas would be highly welcome in cities not only from a viewpoint of urban development in the new economy but also from an ecological perspective.

One of the seven land use classes of the ISIS-model is urban nature sanctuaries. These get the highest valuation from the viewpoint of attractiveness and a quite good effect on ecological assessment of sustainability. ISIS additionally depicts this urban lawns and seminatural, protected area. But where could the area for urban nature sanctuaries come from?

There are several possibilities. The new economy can do with a much lower specific amount of land. Moreover, it makes obsolete many area-consuming activities in their present form such as insurance, banking or office buildings. For example, in telework three workers can share one desk which could decrease consumption of space by 2/3. Banking is moving into the Internet, as does mature insurance business. Therefore the new demand for a highly attractive outdoor environment can be fulfilled from these areas. With decreasing importance of mature economy the ISIS-model depicts how land could become available. But the new economy, with the additional wealth it generates, also increases demand for land for housing. It depends on political decisions how land use will change. Whatever the policies, ISIS depicts the resulting effect of land use on the urban attractiveness and on the development of the new economy. It is easy to see that this is crucial: the new founders need cheap housing in the beginning and attractive outdoor areas somewhat later. There are conflicts which cannot easily be resolved. A suggestion will be derived from an analysis of cross catalytical networks. (This loop is explained in more details in Grossmann 2000).

A potential cross catalytical network between human beings and nature

If nature is to prosper in spite of regional economic growth and increasing human wealth we have to change the relationship between man and nature so that it becomes a Cross catalytical network (CCN). CCNs consist of two or more subsystems A and B, Figure 7, so that at least two of them are capable of exponential growth on their own (“autocatalytic growth”) and, additionally, the subsystems are linked so that they can support each other and thus can increase the growth of the other (Fränzle and Grossmann 1999). This configuration seems to be essential for successful development.

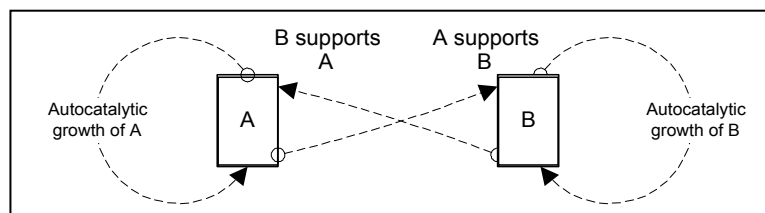


Figure 7: Systems configuration of a cross catalytical network

It was developed by Manfred Eigen (Eigen and Schuster 1978) to explain the origin of life and was extended to more general systems by Clarke 1980. It could be tested experimentally with complex mixtures of chemicals and is a well-researched systems structure. It is not yet used according to its importance. A few examples will be given. Several CCNs drive the present growth of the information society:

- CCNs between new key people and information based companies in the new economy. CCN-characteristics: Autocatalytic growth of new key people is possible because they educate more new key people. Companies can grow by a percentage per year which means autocatalytic growth. Mutual support: If there are more companies which need the new knowledge, the new key people are better off. If more new key people are available the new companies can grow faster.
- CCNs in the development of the Internet exist between new key people, number of host computers and software: Autocatalytic behavior: Better software allows to write software faster, better and more efficient. Mutual support: The Internet trained new key people. As more of them could connect to the Internet, more wrote software for the Internet. More and better software allowed more people to connect more easily to the Internet which made the Internet more appealing which increased the number of host computers in the Internet. More hosts provided access to more people. Host computers cannot grow autocatalytically, but the other components can.

Subsystem between regional human population and nature: This is not a CCN. It could be, because ecosystems can grow autocatalytically as can new key people (as they train more new key people). Support: Regional ecosystems support economic growth through their attractiveness. Support from region to nature: Regional success means increase of buildings, roads, traffic and so on with a negative, not a supporting, impact on regional ecosystems. This could be remedied by building an additional link that feeds back some fixed amount of regional tax income into purchase and restoration of land for nature rehabilitation and conservation. This amount must allow to purchase more land for ecological restoration and conservation than is destroyed by human development. This additional loop would make nature another competitor in the property market; a competitor with increasing

power if the region succeeds. This could match the increasing wealth of its adversaries – affluent people and growing companies.

Integrated policies

Obviously, a region can only succeed through integrated policies. There are vast opportunities for success. Such policies must combine training of new key people, increase of regional attractiveness and deliberate building of CCNs between all regional constituents. There is by now a good potential for such policies to succeed. In particular, the loop described above might allow to overcome or mitigate the ancient struggle between nature and human development.

We now aim at making the ISIS-model a tool in a discursive process to educate people, to help regions in supporting start-ups, and to support development of realistic policies to reconcile man and nature. The emerging information society and its economic restructuring should be used in an aggressive way to mitigate social and environmental problems and to use the inherent favourable potential. This needs new tools. The ISIS-model supports the development of such policies.

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More information on the ISIS-model: <http://moses.alok.ufz.de/moses/>