

ALARM
Scenario narrative document
Version 5.0

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Purpose

A broad consensus amongst experts sees an urgent need to improve the ability to forecast possible changes in biodiversity. For this behalf it is necessary to derive consistent assumptions constituting plausible narratives or story lines, which in turn provide the basis for the integrative interpretation of scenarios from several disciplines run on different computer models. A complementary, cross-disciplinary knowledge base needs to be developed to facilitate a scientifically sound, reconciling interpretation of the partly diverging scenario runs in order to support effective policy decisions (and provide a basis for future integrative modelling exercises).

For this behalf, consistent and plausible qualitative or semi-quantitative narratives are necessary, serving as the common reference basis for scenario simulation exercises using different specialised models which as such cannot be integrated or otherwise coupled. The book summarises the story lines developed in the framework of the ALARM project, describes the modelling results and interprets them against the background of the story lines.

As a sensitivity analysis, but also illustrating the range of possible developments not, or at least not easily accessible to modelling and forecast approaches, three shock scenarios are developed, introducing one exemplary shock in the environmental, economic and societal dimension, and their spill over effects.

On this basis, policy recommendations for integrative policies supporting long-term biodiversity preservation are derived.

For a more detailed understanding, the annexes provide information about the models used and the parameters chosen to distinguish between the ALARM scenarios.

*The best explanation is
as simple as possible –
but not simpler.
Albert Einstein*

The authors

The content of this book is the result of the joint efforts of the ALARM team. The story lines were drafted by Joachim H. Spangenberg as a lead author, with input in particular from the socio-economic team and the modelling group. Simulation results were produced by the different modelling teams:

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Valuable input came from all ALARM partners – as a stand in here the members of the coordination team are named: Josef Settele, Ingolf Kühn and Volker Hammen.

The Project

ALARM stands for “Assessing LARgescale environmental Risks for biodiversity with tested Methods”. It is an Integrated Project (IP) within the 6th Framework Programme of the European Commission (EC). The ultimate aim of the ALARM project is to develop and test methods and protocols for the assessment of large-scale environmental risks for biodiversity. The analyses of the ALARM scientists form the basis for policy recommendations, in an attempt to strengthen evidence based decision making on biodiversity relevant issues.

Based on a better understanding of terrestrial and freshwater biodiversity and ecosystem functioning, ALARM develops and tests methods and protocols for the assessment of large-scale environmental risks for biodiversity in order to minimise negative direct and indirect human impacts. Research focuses on assessment and forecast of changes particularly in biodiversity but also in structure, function, and dynamics of ecosystems. This relates to ecosystem services and includes the relationship between society, economy and biodiversity. In particular, risks arising from climate change, environmental chemicals, biological invasions and pollinator loss in the context of current and future European land use patterns are assessed. There is an improved understanding on how these environmental risks subsequent to each of these impacts act individually and affect living systems.

The knowledge on how they act in concert is poor and ALARM is the first research initiative with the critical mass needed to deal with such aspects of combined impacts and their consequences. Risk assessments in ALARM is hierarchical and examines a range of organisational (genes, species, ecosystems), temporal (seasonal, annual, decadal) and spatial scales (habitat, region, continent) determined by the appropriate resolution of current case studies and databases. Socio-economics as a cross-cutting theme centrally contributes to the integration of driver-specific risk assessment tools and methods and develops instruments to communicate risks to biodiversity to end users, and to indicate policy options to mitigate such risks.

Part A

Introduction and Methodology

1. Introduction

Biodiversity is a complex concept, comprising genetic, species and ecosystem diversity. Biodiversity and its elements contribute to a number of ecosystem services like freshwater management, CO₂ sequestration, and produce direct use values like timber, food and bio-energy. Biodiversity and its elements are indispensable for the continued development of human societies. Although the relation of biodiversity and ecological stability is still disputed, it seems to be clear that a significant loss of biodiversity can contribute to the destabilisation of ecological systems, thus enhancing the risk of system collapses caused by climate change and environmental pollution. While a specific contribution to ecosystem stability cannot be defined, it is plausible that safeguarding biodiversity helps to reduce the probability of systems switching into another state less favourable to humans. Therefore biodiversity protection is a necessary element of sustainability policies. Vice versa, maintaining biodiversity will hardly be possible if the overall development pattern is not a sustainable one.

Sustainable development is a contested notion, with neither an “objective” nor a universally agreed subjective one definition possible. It is a normative concept, with politically defined imperatives. We have chosen a structure of four dimensions, based on UN and EU formulations of sustainable development (the economic, social, environmental and institutional dimension, the latter including cultural aspects). However, there are limitations in defining sustainability beyond general principles and in operational terms, as the specification of how the principles are put into practice will vary with the culture specific interpretations of the agents implementing them.

Narratives (or, synonymously, *story lines*) are qualitative and at times semi-quantitative descriptions of possible futures. They represent plausible, path dependent development trajectories in complex evolving systems, i.e. in systems characterised by uncertainty and thus not accessible to prognoses (as deterministic systems) or quantitative probability and risk calculation (as in stochastic systems). In these cases, story lines provide coherent descriptions on what might be, possible futures which must be internally consistent, but for which a probability of their realisation cannot be calculated. Narratives nonetheless demonstrate potential developments, and help to interpret data from undercomplex models and theories in an appropriate framework.

Scenarios are based on narratives, but both are not the same. Whereas narratives can and must reflect qualitative and other developments which are not accessible to quantitative economic, land use or climate modelling, scenarios combine both, the narratives and model runs. Narratives provide information for the choice of model parameters, and the basis for the interpretation of model runs. Narratives, informed and in certain aspects illustrated by models, with the model results interpreted in the context of the story line, constitute a scenario.

Scenarios are no end in themselves, but are designed to inform political decision making. So one crucial challenge to all the efforts is to make the results usable for real-world politics, to generate advice to decision makers which can be seriously taken into account before a decision is taken, as it is both relevant and reliable.

One key question of decision makers is (and must rightfully be) not only which are the implications of different developments, but how to change trajectories, how to switch from one development path to another. Regarding biodiversity loss this is a rather urgent question, as there is a broad consensus amongst expert scholars that the rapid loss of biodiversity continues, although the number of species lost (let alone the loss of ecosystem and genetic diversity) cannot be quantified. From a policy point of view, this situation constitutes an urgent need to improve the ability to forecast the trends of pressures on biodiversity and the effectiveness and efficiency of measures to mitigate them.

Biodiversity is influenced by a combination of natural processes (e.g. evolution of species and systems, natural catastrophes, succession) and anthropogenic pressures (e.g. land use, nitrogen deposition, climate change, alien species invasions). Changes in biodiversity have impacts on ecosystem stability (although it is not fully understood how) and on the socio-economic system, and vice versa. Biodiversity is an element of the linked human-environment system but research so far has mainly concentrated on isolated elements of this system and not on the system as a whole, and of the role, function and the conditions for effective functioning of individual interlinkages.

Developing effective strategies for biodiversity preservation has been declared a key political task; the World Summit for Sustainable Development WSSD in Johannesburg 2002 and the Biodiversity Convention CBD call for a 50% reduction in the loss of biodiversity by the year 2010, and the European Unions has set itself the target to end biodiversity loss in its territory by the same date. However, as the Millennium Assessment has shown, this will not be achievable without significant policy changes.

For new policies to be effective, socio-economic research has to improve the understanding of damage mechanisms, of how social and economic driving forces create pressures on biodiversity, and to derive suggestions how the pressure economy and society put on the natural system and its biodiversity can be reduced.¹ However, this structure – policy – management – impact – damage analysis is not the only mechanism to be analysed. There is also a dynamic in the opposite direction: as the damages biodiversity suffers do not go unnoticed, they act as a driving force, motivating people, NGOs and others react to them, creating a pressure on the socio-economic system decision makers most often cannot ignore (impact), thus forcing them to act (response). This is not only one of the traditional mechanisms of environmental policy, it also illustrates that nature and society are weakly and asymmetrically coupled co-evolving systems, and the evolution of one cannot be understood when ignoring its interaction with the other.

1 Simultaneously, research – mainly from natural science – is needed and under way for instance in the ALARM project *how* these pressures affect biodiversity. The results of this research need to be accommodated by the story lines, scenarios and the recommendations derived from them.

To gain such an understanding will require the transdisciplinary combination of capabilities, concepts, insights and tools of several disciplines (including, but not limited to ecology, chemistry, economics, and political science). Narrative development and scenario modelling are amongst the essential tools for studying changes of biodiversity and their impacts in order to provide well-founded policy options. A major challenge is to ensure that the assumptions used in these various tools are consistent. The current situation of non-integrated and often contradictory perceptions, recommendations and predictions is not sustainable in any sense of the word.

1.1 The tools: narratives or story lines

Since the background vision of a sustainable Europe is a complex narrative, the level of detail which should be included in the story lines is a matter of discussion, as is the kind of stakeholder participation and the target group specificity which is needed and possible without losing the overarching appeal of the scenario. As a general rule, key criteria in constructing narratives are that the developments or events assumed must be possible, plausible and – for a specific political approach and the resulting development trajectory – also probable. As probability estimates are dependent on what the researcher assumes how certain actors will most probably react to specific situations, actors (politics, business, civil society, population at large) must be named and their attitudes and reactions described.

Generally, the population participates in socio-economic processes in two key functions: as citizens and as consumers. Although these are two aspects of the same individuals' identity, they include different preferences and contradictory action depending on the role assumed. So the *citizen* might act based on the insight that protecting social security, environmental functions and in particular biodiversity is a precondition for their long-term availability and thus constitutive for maintaining the individual freedom of choice. Therefore s/he would accept or even support policy measures intending to modify and redirect certain production patterns and individual behaviours (consumption patterns), endorsing them for the sake of more important values, many of them closely linked to sustainability. The same person, however, might be opposed to them in his/her role as a consumer as s/he experiences them as restrictions of consumer choice: opinion polls and voting of citizens tend to suggest sustainability preferences, although the everyday routines of the same people in their roles as consumers seem to indicate rather the opposite. Consequently, propositions restricting consumer choice will remain to be a difficult, but not impossible issue to deal with in sustainability policies (green taxes are just one example, bans on certain products or recycling duties are others). However, the wasteful consumption patterns, contributing to resource shortages and pollution cannot remain unchanged if sustainable development – and with it biodiversity preservation – is to be pursued.²

² In this respect it is promising that the pan-European "Environment for Europe" process has dedicated its latest conference in Belgrade, October 2007, to the issue of sustainable consumption and biodiversity – a crucial, but so far rather neglected bridge between two issues long (and with limited effect) on the policy agenda.

This is all the more true since by now a global consumer class is emerging, orienting its consumption patterns along the lines of the European or even the American model. This places a specific responsibility on affluent consumers particularly in the rich countries (the “Global North”) to illustrate by modifying their own consumption patterns that a good life is possible without ruining the biological basis of their civilisations, emphasising the qualitative aspects of consumption rather than the total volume as a contribution to the quality of life. Only this way, practicing leadership by example, new consumers in the less affluent South can be convinced to modify their aspirations.

Unfortunately, so far transition strategies for changing consumption patterns do not exist; they are the domain of research rather than policy making. What is clear however, is the need for collective action, for changing orientations by a combination of push and pull measures, and the need to exploit the fact that the preferences of *citizens* may support these measures, even if some of them are restrictive, for the benefit of the common good. Obviously, here is a field where diverging opinion will exist in a pluralistic society, and the different scenario story lines have to assume different orientations of the majority of consumers, while not neglecting the conflicts of interest and the influence of (possibly significant) minorities.

Another relevant actor is the business sector. Which role will Corporate Social Responsibility play in the future, is it really a movement to change the short term oriented shareholder capitalism orientation? Can there be responsibility along the whole of the production chain, and can it include the retail sector, the consumption phase and the final disposal or recycling? Which kind of economic structures would be needed for a supply of goods at minimal external costs? Which kinds of politics would be needed to get such structures into place (like ZERO emission production sites, co-product use, trans-sectoral but intraregional use of by-products)? What would be the effects on waste generation, the relation of central and decentralised production, and on recycling? The scenarios developed represent different answers to these questions, while maintaining coherence with the answers derived for consumer behaviour.

Such a change will as well have significant implications on the international level. For the Global South (the periphery of the global society), it is rather obvious that selling resources is no way to become rich: instead the share of raw materials in the total export volume is correlated to the share of the population in poverty.

For the North, questions arise whether the relation of capital investment and savings has not changed its character altogether by the development of global capital markets. What then is the role of the banking and insurance sector in the pursuit of sustainable development? Are the recent indications of a dedication to sustainability a first sign of a new trend? Will a race to the bottom dominate the national developments in social and environmental policy, or will there be a stabilisation effort on a high level? In particular, will business accept the need for higher wages (the traditional rule: inflation plus productivity gains), as this is the precondition to have a stable social security system (preferably a collective system based on solidarity) plus simultaneously increasing disposable incomes (although the increase would be slower than without social and environmental sustainability policies)?

Again, the different story lines will explore the consequences of choosing different answers to these questions in a coherent context. For this behalf they will have to include not only the qualitative factors, but also descriptions e.g. of the role of the unpaid economy (including the informal economy, but also comprising caring and voluntary community work). Changes in this domain can have quantifiable impacts on the overall economic development, which in turn could be an input parameter for the quantitative modelling. As modelling is only an illustration of part of the narrative, the missing points and mechanisms must be identified and highlighted in the story line. In order to be convincing, the narratives must be convincing, based on a transparent and plausible structure of what is influenced by what.

Much of the international scenario work on climate change is based on the IPCC's SRES story lines and simulation runs. Their story lines are based on two orthogonal dimensions with scales from global to more regional orientation, and from economic to more social/environmental preferences. However, these are not the parameters used in the modelling, but an implicit mental model is used to translate these storyline parameters into scenario assumptions regarding population growth, GDP development and rates of technological progress (and assuming a shock-free development)³. Of these, population growth appears to be the least questionable, but still significant changes have to be made for the latest version of the IPCC reports, and for Europe it is made more complex by the need to take international as well as intra-European migration into account. This cannot be estimated by just extrapolating the past trends, as otherwise some countries, in particular in the Baltic region, would be completely abandoned before the midst of the century, which is not plausible, let alone probable. Assumptions regarding changes in migration patterns are necessarily speculative, however, but indispensable for the modelling exercise.

1.2 The tools: modelling scenarios

Modelling, illustrating specific aspects of a story line by computer simulation runs, cannot aim at deriving predictions (given the uncertainty prevailing in evolving systems), but intends to illustrating aspects of a plausible development trajectory (as described by the story line) by means of a model (theoretical or computer model). This illustration can only be a partial one, and there is an undeniable risk that modelling results might catch more attention than they deserve in comparison to the story lines, and that what is mere information about development trajectories and their impacts, about orders of magnitude might be misinterpreted as a prediction about reality, in digits.

³ There are three questionable assumptions underlying the basic design of all IPCC SRES scenarios; they are derived from a specific mental model, not discussed and neither tested empirically nor by economic modelling. These assumptions, decisive for the scenario parameter setting, are: (1) Globalisation leads to a higher growth and to a more equitable distribution of income. (2) A regional focus (in A2/B2) is correlated with higher population growth and thus higher environmental impacts. (3) If the world is not converging, technological change will be more diverse, and less rapid. In our scenarios we do not share these assumptions, but still use the climate change data based upon them, interpreting them with respect to diverging basic assumptions and modelling results.

Integration is dependent on the combination of lessons learnt from climate, land use, biodiversity and economic models. They all have their own logic, time schedule, parameters, in- and outputs, and cannot be easily integrated. What might be possible, however, is to construct a shared framework, where the parameters chosen and their values can be compared and, at best, aligned. For instance, the climate models are based on assumption about population and economy growth, and technology development. Climate change impacts on economic parameters should be used as an input to econometric scenarios (they usually are not), and the econometric growth trajectories resulting should be in line with the climate scenario assumptions. Such an alignment if conducted systematically needs to be an iterative process, which unfortunately goes far beyond the project resources and thus its capabilities. Consequently, in the best of cases the parameters coincidentally converge; in all other cases the comparative analysis should help to contextualise the model results by pointing to the differences in parameter estimates. This is all the more important, since climate, land use and economic development are key pressures impacting the state and the future development of biodiversity, and must be analysed as drivers of it.⁴

When talking about drivers, this does not imply the use of a conventional DPSIR (Driving Force, Pressure, State, Response) heuristic as used by the EEA and EuroStat, or similar scheme as the basis for analysis, but refers to a rethinking of such themes within a multi-dimensional sustainability context. This approach and the methodology developed for this behalf are documented in a special issue of *Ecological Economics* (forthcoming).

For all scenarios, a status quo or “do nothing” baseline is not explicitly developed, nor a business as usual scenario extrapolating past trends in a linear fashion. Both must be distinguished from the policy scenarios developed, each of them representing one existing policy orientation and its specific understanding of sustainable development. Neoliberal policy trajectories are elaborated in the GRAS scenario, BAMBU represents the policy mix so far usual in the EU, and SEDG is a sustainability scenario based on more ambitious and less ambivalent policies than BAMBU.

For the modelling exercise, climate variations were calculated based on the existing SRES scenario, which – by means of interpretation of their results in the context of the story lines – are linked to the ALARM scenarios. For land use, the scenario generator MOLUSC has been developed, while the socio-economic modelling uses GINFORS, a global, highly endogenised econometric bottom-up model; both have been integrated as much as possible. Biodiversity is modelled with a range of tools, and again the interpretation is undertaken against the background of the scenario narratives (more details about the modelling tools are provided in the annex).

Given the partly diverging results of the simulation runs and the need for coherent scenarios, the quantitative results are reinterpreted against the backdrop of the story lines to reconcile them. Consequently, not the quantitative modelling results, but their semi-quantitative interpretations are the “hard” results of the scenario exercise. They are used as the basis for

⁴ For details about the models used (econometric IO-model, land use model, climate model and biodiversity model) see the journal publications on the ALARM scenarios.

deriving policy recommendations (including those regarding the improvement of scenario tools).

2 Status quo and challenges

2.1 Models

So far no comprehensive model has been developed integrating the diverse relevant ecological, economic, individual and societal processes. Actually, this is not only due to the overwhelming complexity such a model would have to accommodate, but also due to different system characteristics like system boundaries and time scales, and the lack of knowledge regarding their interactions it would have to cover. Probably, no such integrated model is possible, and what could be achieved at best is a group of separate but coupled models. Amongst these, externally set assumptions would be harmonised and the results of one are used as input to the others (e.g. as table functions). For instance, while population development could be based on joint assumptions, growth data from an economic model might be used by land use and climate models. In a next step, these models would interact amongst each other, harmonising for instance the emissions from land use and the climate impacts on land use. Their results on the one hand would influence the economic modelling exercise by inducing the need for adaptation expenditure or by modifying productivities, and on the other hand the biodiversity modelling so far mainly based on climate envelopes without taking those additional relevant parameters into account which can be derived from land use and economic models (and the precipitation changes generated by climate models as well). Obviously, such a process of model harmonisation must be an iterative one. Unfortunately, the state of the art is rather far away from this optimal situation. Instead socio-economic, climate, land use and biodiversity models exhibit a wide range of assumptions concerning population development, economic growth and the resulting pressures on biodiversity.

The SRES climate scenarios, with their diverse and sophisticated models, do neither include climate protection policies so far, nor the effect they may have on economic growth. Consequently, the Millennium Ecosystem Assessment scenarios, which include climate protection policies, expect less and slower climate change than the SRES scenarios (which at the same time are considered rather conservative by other sources). Others argue that with the foreseeable peak of oil production not later than 2030 and of gas less than 20 years later, the total volume of oil and gas (including so-called unconventional sources like oil sands and deep sea and permafrost deposits) the total volume of carbon to be released will not even reach the lowest SRES projection, unless coal incineration is expanded dramatically – which would dramatically change the climate, but delay to collapse of the fossil fuel based economy not more than another 80 to 100 years. So far none of the diverse climate models (the difference between two models emulating the same scenario is frequently larger than that between two different scenarios run on the same model) takes the resource limitations into account, let alone their economic impact – and their feedback on the emission trajectories.

For long term economic predictions computable general equilibrium (CGE) models are frequently used, but they are unable to properly reflect the structural change beyond mere price effects. This change, however, caused for instance by technology development or preference changes can hardly be endogenised in such models, but is characteristic to any open society and market economy, in particular in the long run (which may be a rather short term view from a climate research perspective). In particular the fact that CGE models are often based on rather linear extrapolations of past trends regarding population growth, substitution elasticities etc. hinders a realistic assessment of possible future development trends.

Biodiversity models suffer from the fact that it is comparatively easy to assess the impacts of well defined patterns of temperature change on the distribution of single species or groups of them, but harder to take precipitation patterns into account, harder still to project not only species distribution but also future population densities across a wide range of taxa (abundance is one factor necessary to calculate diversity), and probably impossible to do so simultaneously for genetic, species and ecosystem diversity. Even measurement problems for biodiversity (as opposed to species numbers) are not solved, as none of the measures suggested so far covers all three aspects of biodiversity as defined by the CBD (genetic, species and ecosystem). Picking out some elements (like endangered species) may imply policy measures which are detrimental to other elements of biodiversity. Consequently, there is no such thing as an overall meaningful, let alone a generally accepted index of biodiversity.

In a similar vein as for climate change, what needs to be discussed and is not yet clear (neither in the scientific discourse nor in the project) is the feedback from biodiversity loss to economic growth, on emission trajectories and on the state of society. The loss of ecosystem services has been discussed, but neither comprehensively nor can such a loss directly be correlated to econ losses from biodiversity loss. This lack of clarity has two reasons going beyond the challenge of working on an issue which is at the interface of bio-geo- and socio-economic systems and the disciplines analysing them. The two reasons are

- First, the impact is not straight at all, but includes diverging and overlapping effects. So for instance biological invasions can lead to new contributions from agriculture, or can reduce the productivity of existing ecosystems. The cost of damage can be high, but the cost of fighting invasions can be even higher. At the same time, countermeasures at the local level have developed into a major source of income for the rural population in some places, triggering economic development processes impossible without such decentralised spending of public funds.
- Secondly, some of the foreseeable impacts of biodiversity loss will materialise far beyond the time horizon of economic modelling (but within the range of land use and climate modelling time scales). Thus they are justifiably not reflected in those current economic models which are sensitive to environmental changes (dynamic, highly endogenised Input-Output models), whereas those models used for long term projections (CGE models) do not include feedback loops. Consequently, such interactions tend to escape the attention of the researchers: the deficit of absorbing relevant news if not immediately relevant for the own

work, in line with given expectations and presented in familiar terms is as visible in science as it is in politics.

2.2 Story lines

Therefore as a first step it is necessary to derive consistent storyline assumptions and scenario interpretations from a comparative analysis of existing models and narratives from several disciplines. Assessing their overlaps and the possible contradictions between the results of one and the assumptions of other can help get a better assessment of the relevance of specific scenario results by contextualising them with the outcome of other modelling exercises. Similarities in results can confirm the robustness of the scenarios chosen and that the results are not mere model or data artefacts, but like any sensitivity analysis, the lack of similarities can also raise doubt regarding specific outcomes. By interpreting the modelling results (including climate and biodiversity) in the context of the ALARM scenario story lines, they become an integral part of the ALARM scenario exercise. This way, a complementary, cross-disciplinary knowledge base can be developed in order to support effective policy decisions and provide a basis for future modelling exercises on all levels. Obviously, all scenarios start in the current reality and evolve as a series of gradual changes, triggered by the policy assumptions in the scenarios, thus representing an incremental approach to a sustainable development pattern with special emphasis on the preservation of biodiversity.

While improving scenarios and solidifying their results by comparative analysis, still the limits inherent to all these modelling exercises must be assessed. For instance, what is somewhat speculative and therefore better addressed in the story lines is the development trends of external factors. To illustrate this point, consider the resource price developments of the last five years which had not been anticipated by experts and thus not included in the scenarios. Since rerunning the scenarios is beyond the project resources, price changes are integrated into the narratives and thus the modelling interpretation; they add to the uncertainty when describing each scenario, but less so for their comparison, as the deviation from reality is the same for each scenario.

Some open questions the scenarios have to deal with cannot be modelled with the available resources; preliminary qualitative or semi-quantitative answers, now part of the story lines, have been derived from expert discourses based on modelling experiences. This includes questions such as “Even if for Europe the economic loss from declining agriculture and forestry, as far as this has to be expected, may be harmless, what does this mean in a global context with increasing food shortages and countries hoping for EU exports, not imports? Will food/feed prices then rise dramatically? What will be the feedback on Europe?” Other questions can only be dealt with in the story lines: “Will famine be the consequence? Or is there a risk that with changing climate pests and parasites may spread leading to a famine resembling the Irish experience of the 19th century? If anything like that threatened to happen, what would be the societal reaction? E.g. a move towards plant biotechnology, hoping for drought resistant crops, with a resulting further narrowing of the genetic base of agriculture and higher vulnerability to pests?” Fortunately, for some questions the models provide an

answer, at least the combination of different models: “what will be the impact on biodiversity of climate and land use changes induced by climate change?” or “If the gulf stream collapses, what will be the implications for climate, economy and biodiversity?” The latter kind event we would call a “wild card” or shock scenario, described as a deviation from one of the basic story lines based on one specific event or factor. In this particular case, the shock is modelled as a deviation from the GRAS scenario (see section 5 for the shock scenarios).

Probably the most important methodological problems result from the gradualism, i.e. the assumption of marginal, linear changes (i.e. no irregularities, no discontinuities, no sudden shocks), which is typical for the internal dynamics of simulation models. To be policy relevant, however, scenarios have to take the effects of non-linear developments into account, in particular if they are severe enough to have a significant impact on the development trajectory. The IPCC’s 4th assessment was confronted with a similar challenge to deal with the existence of “wild cards”, i.e. unpredictable disturbance events with long-term and large-scale impacts. One way to deal with them is to develop a variety of *shock scenarios* against the backdrop of linear simulation runs, to illustrate how future developments can be different from any extrapolation of past trends. The real future most probably will include such shocks, although by their very character we cannot predict them, neither which one will occur nor when this will be the case (nonetheless vulnerabilities can be assessed, and precautionary measures can be taken, reducing a probability which is not quantifiable). The shocks we analyse include an economic one, caused by a significant and sudden increase in oil prices, reducing the level of economic activity, a social crisis in form of a new pandemic, realised as a narrative using insights from the modelling experience and based upon the limited data available from recent strategy developments and cost estimates available generated by the WHO and the World Bank when dealing with SARS and the 2004/2005 avian flue epidemics. Finally, an environmental catastrophe will be described, the collapse of the thermohaline circulation, based on recent climate modelling results and socio-economic modelling experience.

With the help of the comparative analysis of different scenarios and the illustration of some of their aspects by different models, and by using shock scenarios to extend the range of potentially possible futures taken into account regardless of their probability, the validity of future projections can be enhanced.

In the political domain, this allows to develop sustainability strategies and test them regarding their robustness in a wide number of possible futures. Such “safe bet” or “no regret” policies are the first choice in situations of enduring uncertainty (which in policy making is more often the case than not, in particular with respect to long term objectives). In the scientific domain, such an analysis provides input for future modelling exercises, by creating a shared interdisciplinary knowledge base which can be used in future scenario development. It helps to assess the relevance of feedback loops and the robustness of scenario-based expectations and recommendations.

3 The narratives

For ALARM, the development of story lines is based on an innovative framework of different socio-economic and political strategies for Europe that considers both socio-economic and political developments, and climate shocks and stabilisation policies plus biodiversity preservation efforts. The framework consists of three basic scenarios characterised by qualitative story lines (described in detail in section 4), and three deviations from the basic scenarios (shock or wild card scenarios, described in section 5). Accessible aspects of the scenarios are illustrated by simulation runs of different models and their results included in the story lines.

The story lines describe three alternative, internally consistent policy strategies, their priorities and objectives, and how they are tried to achieve (possibly, but not necessarily successful):

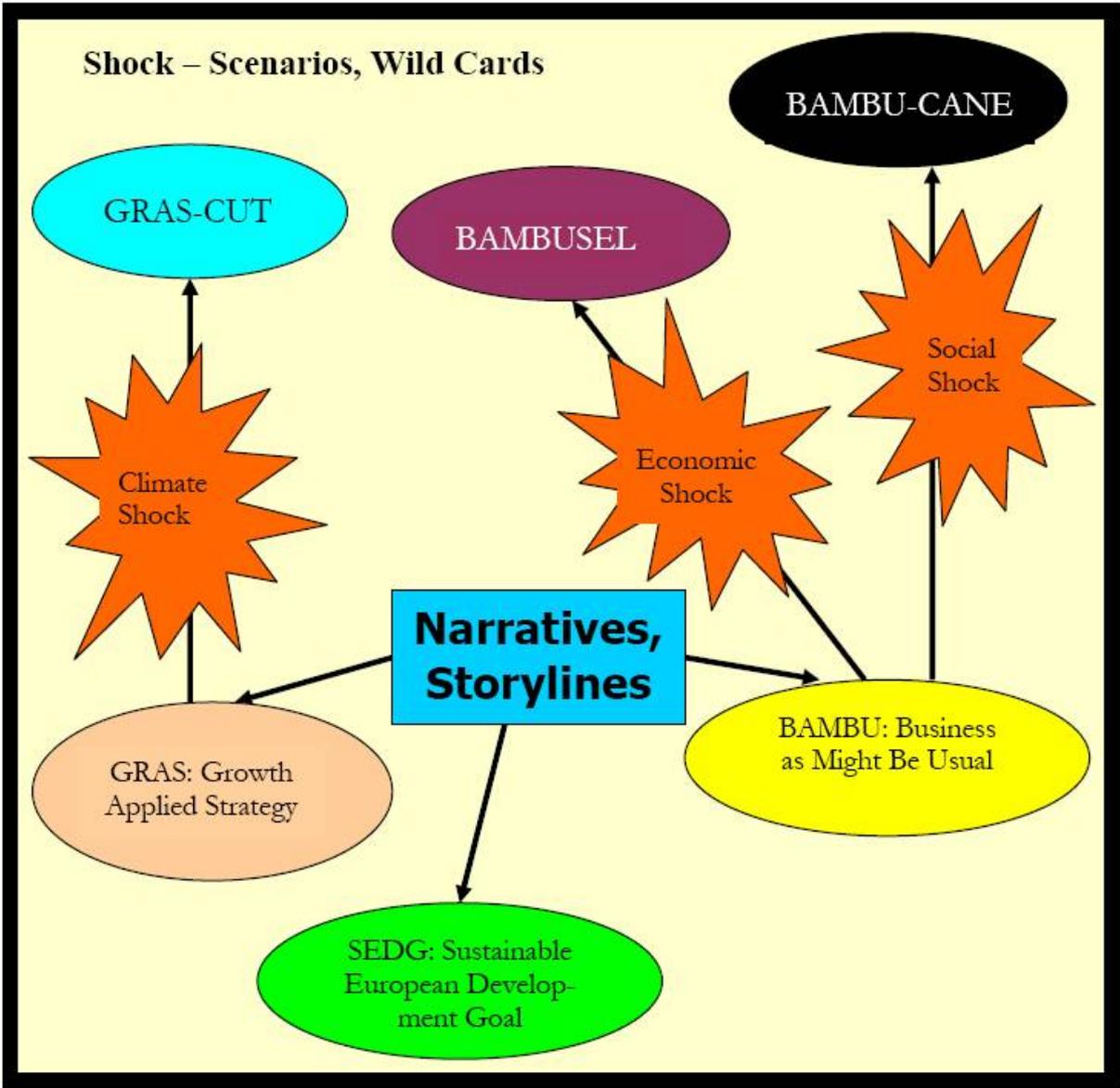
GRAS: GRowth Applied Strategy scenario. GRAS is a kind of explorative scenario, illustrating how the world might look if the economic and political paradigms of neo-liberal deregulation and globalisation policies currently dominating in the top levels of politics, business and media are permitted to determine future decision making. Deregulation, free trade, growth and globalisation will be policy objectives actively pursued by governments. Biodiversity and sustainability policies play a role, but are ranking comparatively low in the policy hierarchy. Environmental policies will focus on damage repair and limited prevention based on cost-benefit-calculations.

BAMBU: Business-As-Might-Be-Usual scenario. BAMBU is an explorative scenario as well, but with more of a forecasting character: what might happen if we do what we intend to do? It is based on the assumption that currently decided policies remain in place, and so do regulations. For policies adopted but not yet in force or effective, BAMBU assumes their implementation and enforcement. Furthermore, the prevailing trajectories of EU policies are maintained, implying additional policy measures for instance in the fields of climate change mitigation and biodiversity preservation. However, BAMBU rules out efforts to leap-frog in environmental and social policies as much as their dismantling. Environmental policy (including climate change mitigation and adaptation measures) is mainly perceived as another technological challenge. At the national level, deregulation and privatisation continue except in “strategic areas”. Internationally, there is free trade.

SEDG: Sustainable European Development Goal scenario: SEDG is based on a normative backcasting approach, deriving the measures to be taken from a combination of what is considered necessary from a sustainability and biodiversity point of view (including the stabilisation of atmospheric GHG concentrations), what is acceptable from a social and political perspective, and what is considered plausible in terms of policy reactions. It aims for a competitive economy and a healthy environment, gender equity and international cooperation, thus enhancing the sustainability of societal development by integrated social, environmental and economic policy. SEDG illustrates the best hope, if insight in sustainability challenges is translated into policy action, and it must be explained carefully, as it sometimes goes against the mainstream consensus, e.g. in claiming that social security and

rising incomes are not mutually exclusive, that workers rights are no impediment for economic growth, etc.

Figure 1: The ALARM scenarios



For all scenarios, but for SEDG in particular, the assumptions taken must be justifiable. For SEDG the question is, how radical must the policies assumed be, in order to meet the sustainability criteria for the outcome, and simultaneously, how radical can they be without violating the plausibility and probability criterion? This is necessarily a subjective assessment under uncertainty, and can best be dealt with in an open discourse with experts and stakeholders which has been held in the ALARM Consultative Forum. Ideally, after a first modelling exercise and with the results of first scenario runs available, an iterative process would have to be started to make sure the objectives are really achieved. Unfortunately, limited resources only permit to do the first step – the SEDG scenario is best understood as the first step in an ongoing journey.

These three story lines describe drivers of environmental change, e.g. economic development, technological changes demography, etc., and their impacts as illustrated by the modelling exercises. We use this approach, not trying to quantify biodiversity, but to identify and as far as possible quantify the *pressures on* biodiversity, and to identify the driving forces behind them. The policy advice, based upon the scenarios (story lines plus interpretation of the simulation runs), must then be how to change the driving forces (create bifurcation points, change the trajectories, induce structural change) in order to protect biodiversity by reducing the pressures upon it. What is measured in this case is pressures and drivers, not biodiversity as such, based on the underlying assumption that the higher the pressures, the higher the loss of biodiversity, and that lowering the pressures is an effective means for the long term comprehensive preservation of biodiversity (which does not rule out that as emergency measure immediate curative action must be taken).

The environmental change drivers are then translated into quantitative scenarios using specific methods for the three categories of variables: climatic, N deposition and land use.

Part B

The scenarios (story lines, simulation results)

The story lines are intended to serve a double purpose: on the one hand, they deliver arguments about *why* the specific scenario assumptions are considered plausible as elements of a specific, consistent policy context. Secondly, they permit inclusion of those assumptions that are not quantifiable and cannot be modelled, but are relevant for the results.

However, the truth is always in the eye of the beholder, and thus it is the stakeholders which have to have the ultimate say on whether the scenarios are accepted as plausible and consistent, leading to possible futures (without necessarily stating specific probabilities regarding which scenario might indeed be realised). Therefore the scenarios are undergoing a permanent process of consultation, including internal feedback from within the ALARM project and external input from the Consultative Forum, the ALARM advisory board and discussion partners in the Commission and different groups of civil society.

The scenario are organised to first highlight the basic philosophies and attitudes to be elaborated, and then go on describing the policies chosen to implement these overarching objectives. The computer simulations parameterise these policies as far as possible; their results show how far the ends are indeed achieved by implementing the chosen means (as far as modelling can do so). These results are discussed in comparison and with reference to the limits inherent to quantitative models, providing the final scenario outcome.

Whereas the outcome emphasises the resulting biodiversity trends, biodiversity is not the focus of the policy description. This has two reasons: on the one hand, we do assume that, in most cases, biodiversity is indeed not in the focus of decision making, and secondly, the policies described cover the most important driving forces of biodiversity loss. Land use changes are addresses in settlement trends, agricultural and transport policies; the key factors for invasions are the development of future trade and the institutional setting (existence of rules and controls). The success of climate mitigation depends on energy and transport policies, and chemicals' impacts on biodiversity are largely determined by agricultural and chemicals politics.

All these drivers are covered by the story lines, and they help to take additional factors into account not covered by individual simulation runs. Scenarios, in this sense, are a tool for integrating information, broadening the underlying knowledge base and improving the suitability of existing, but dispersed information as basis for decision making in a knowledge based society.

1 GRAS - Growth Applied Strategy

1.1 Objectives

GRAS is a scenario strongly based on economic liberalism. It aims at maximising the freedom of business, to dismantle all regulations (national or international) which might interfere with the market mechanism and thus lead to inefficient allocation, and consequently to reduce the role of the state and focus on international competitiveness. The privatisation of publicly owned enterprises is part of these efforts, as is reforming the social safety net to “enhance its robustness”. This includes the transformation towards a more enabling than caring system, emphasising individual responsibility and the need to keep costs in check. Environmental policies rely on the market for medium to long term solutions, but may be forced to intervene in the short run, focussing on damage repair and limited prevention based on cost-benefit-calculations. No emphasis is given to biodiversity.

Deregulation, free trade, growth and globalisation are policy objectives actively pursued by governments. Due to an aversion to state interference with economic processes and an emphasis on national interests, no additional competencies are delegated to supranational institution. The need for national policies is emphasised, with a focus on competitiveness. On the European level, the council and thus member states will get stronger control over EU politics, leading to re-nationalisation of European politics rather than to deepening integration. However, issues of power distribution and influence are not perceived, let alone publicly discussed as an element of the sustainable development concept.

The emerging strong state is focussed on its “core competencies”, i.e. is not intervening in the economic processes, but rather uses its strength to improve the conditions for business (legal and institutional framework, support by RTD), to guarantee competitive markets and to prevent social unrest. While social services are reduced, law enforcement and military strength are emphasised as part of an international system to defend the freedom of markets and exchange. Democracy is mainly seen as the freedom of choice of consumers, whereas more “invasive” forms of participation, in society (direct democracy) as in the business sector (co-decision), are reduced. Freedom of information is limited, as this might cause conflicts with classified business information.

1.2 Ideologies and orientations

Social and environmental problems are not ignored, but no fundamental change in our current patterns of production and consumption is assumed to be necessary. Instead the market is considered to be essentially capable of solving all relevant problems in the most efficient manner. Thus enhancing economic growth by deregulating (setting market forces free) is seen as the primary objective of policy, and growth is predicted to deliver as a side effect social benefits such as more distributional equity and environmental benefits such as reduced pollution (Kuznets Curve and Environmental Kuznets Curve). The trust in the market leads to a retreat of politics from interference with the economy, further fuelled by a certain pro-

individualistic and anti-etatistic attitude of decision makers. The basic economic *philosophy* of this approach has been described by Georgescu-Roegen (1976, p.4-5): “An inflation, a catastrophic drought or a stock exchange crash leaves absolutely no mark on the economy. Complete reversibility is the general rule” [...] resulting in the “economic myth that man will forever succeed in finding new resources [...] and harnessing them to his benefit. [...] The favourite thesis of standard [neoclassical] and marxist economists alike [...] is that the power of technology is without limits. We will always be able not only to find a substitute for a resource which has become scarce, but also to increase the productivity of any kind of energy and material. Should we run out of some resources, we will always think up something [...]. Nothing, therefore, could ever stand in the way of an increasingly happier existence of the human species.”

The labour market is one market amongst others and would be in a balance (i.e. would deliver full employment) if it were not distorted by too much red tape, hindering wages from falling far enough to enhance labour demand and thus create jobs. Lowering labour costs and salaries is thus a necessary contribution to employment generation. Employment is an important policy goal (to be achieved by stimulating growth), not least to limit social private and public security expenditures. This is all the more important as the public coffers tend to be empty, since to unleash the market forces, taxes are reduced, and consequently state expenditure is declining, including subsidies for social purposes as well as investment in public infrastructure. However, some support measures are also part of the labour market policy, in particular support for female education in professions such as management, engineering and science to avoid the foreseeable deficit of highly qualified young staff members.

The overall tendency also has impacts on the public consciousness: economic values dominate, hedonistic and selfish utility maximisation is rewarded and thus flourishes, identity is linked to fashion and artefacts (*homo economicus* becomes increasingly a reality). Care for nature and social cohesion is limited; few volunteers work on these issues. In private life, a risk taking attitude is enforced by emphasis on individual responsibility and the lack of alternatives (“must do” feeling). A material lifestyle and a high willingness to consume prevail, while the capability to consume limited by relatively low purchasing power, except for upper income decile.

The legal right to know is maintained, but the opportunity of making use of it in practice is eroded by administrative hurdles. Policy makers have a preference for in-house decisions without public debate, considered a more efficient means of government. This contributes to the trend that the acceptance of regulations and the public confidence in political decisions is eroding; compliance has to be achieved by control and enforcement measures.

Problem solving competence is mainly expected from the market and from technological progress, resulting in high esteem for science and engineering. Trust in politics decreases.

Resulting policy hierarchies

The tendency to more market based and less democracy based decision making, with some authoritarian elements and combined with business dominance leads to the appropriation of decisions by one category of actors. Decisions are delegated to advisory bodies and PPP (public-private-partnership) initiatives. Policy coordination focusses on ‘slimming’ administrations; trying to enhance the effectiveness of institutions by introduction of market elements.

The attention dedicated to the fight against/combating corruption is limited. In environmental and health policy, there are no extended ex ante impact assessments, regulation via liability law is thought to be effective (following the US model). Against crime and social unrest “heavy handed” authoritarian security measures are taken, suppressing these symptoms, but paying limited attention to the root causes.

Politically, this results in a preference for voluntary agreements against policy regulations in all areas of politics. In the field of social security (pension systems, public health insurance, unemployment benefits, basic subsistence payments etc.) the dominating trend is to dismantle public systems and to replace them by market based solutions and enhanced individual responsibility. Preferred environmental regulations – if considered necessary at all – use market instruments and are limited insofar as they must not impinge on the competitiveness of business.

Deregulation of business, dismantling of trade barriers and national specialisation results in increasing trans-border flows of capital and goods, which are rightly perceived as one of the main drivers of economic growth. The dominance of capital accumulation interests over the public good is considered justified, since private accumulation is seen as the basis and precondition for maintaining the public good in the long run (which will happen as a result of market processes with no further policy intervention needed).

For international conflicts of interests, the pursuit of military strength (on EU level and nationally) is the preferred option. Disaster preparedness is considered a technical task, with an important role for business or civil society.

1.3 Trends

Demographic trends (incl. labour force participation)

Low and decreasing population growth incl. migration, topped up by some invited migration workers from outside the EU lead to overall stabilisation of an ageing population (with slow increase of life expectancy, and a low birth rate). Migration from Eastern to Western Europe peaks (before 2005: +0.1% p.a., 2005-2015: +0.3% p.a., after 2015: +0.1% p.a.); inside the countries migration to large cities continues.

Increasing flexibilisation of employment conditions including retirement age leads to increasing labour force participation of women and elderly despite unemployment.

Spatial structures (settlements, income)

Urbanisation goes on, in particular in Central Europe, contributing to urban sprawl, with a decreasing population in small to medium sized cities. Additional car commuting will occur through increasing share of mobile and teleworking outside the centres and neglect of (rural) public transport. In rural areas peri-urbanisation prevails, resulting in dispersed settlement patterns. Big cities and rural areas both benefit from +1% p.a. regional GDP above national average. The location of agricultural areas is based on rent maps, exploiting the best soils and abandoning others.

In national and EU Regional Policy and planning no strict planning for socio-environmental spatial functions takes place, sealing of soil is no criterion except in situations of immediate economic impacts. EU funds are reduced in total volume, decision making is delegated to the regional level while the specific objectives are relaxed, integrated assessment for sustainability (IA) is neither mandatory nor frequent. No response to changing regional resource availability patterns due to environmental impacts is foreseen.

1.4 Politics

Economic policy

The main objective of economic policy of the Union is growth and competitiveness, and so it is for the member states (although permanent export surpluses of some countries endanger the common currency). The preferred means are: deregulation, privatisation and austerity. Regarding policy instruments, there is a strong preference for economic instruments. The social and political environment are favourable to enterprises (in particular TNCs), to investment, new technologies, enhancing investor confidence, but market entry barriers increase through such policies, undermining market competition and leading to oligopolies.

MAI is reloaded or equal or preferential treatment of FDI otherwise guaranteed. Minimising state interventions into the economy by deregulation of social and environmental standards is introduced to accelerate growth, but strengthening police, courts, the enforcement of property rights and contracts reduce the fiscal gains. In regulation, there is a preference for voluntary agreements without enforcement mechanisms over legally binding measures. The liability regulation is modified so that the cost e.g. of risk assessments, damage detection and repair are often carried by public authorities to avoid costs for and enhance competitiveness of business.

Environmental expenditure is perceived as investment competing with the welfare effects of other uses, assessed by CBA.⁵ Formerly public services are privatised (GATS: schools, universities, hospitals, transport, communication, energy and water supply); voluntary investment of time and human resources for the public good is welcome, with business partly replacing the state. Unpaid work hardly honoured, except if substitute for welfare state activities.

⁵ CBA is Cost – Benefit – Analysis in monetary terms, for non-market goods based on contingent valuation (willingness to pay analysis).

Fiscal policy

Decreasing corporate tax level, stable labour taxes, no additional eco-taxes lead to an increasing share of indirect taxes. Subsidies are substantially dismantled (except for strengthening competitiveness in strategic areas such as military and aviation, not agriculture). Politics promotes private savings as means to compensate for decreasing pension levels, and aims to reduce budget deficits on all levels of administration to zero. Intergenerational justice is just to justify the limits to public debt.

Energy policy

For the GRAS scenario, energy price trends are assumed based on the (rather low) assumptions of the 2004 International Energy Agency IEA cost scenarios (the 2005 scenarios predict a higher price, but the same kind of trend: declining energy prices in the short run, gradual increases due to higher production costs in the long run).

We assume a slow nuclear phase out due to cost reasons in most EU countries, and a slow diffusion of renewables, with a policy support focus on RTD, not on increasing energy taxes.

Biodiesel is promoted, but due to price differentials and free trade policies, it is mainly imported from Indonesia, Malaysia etc. where it is produced from palm oil. This is the main reason of virgin forest loss, and as the plantations are moving into former swamp sites, the CO₂ released from the ground overcompensates the climate gains from renewable energy.

Social and employment policies

Cohesion is no priority policy objective, except if it is necessary to avoid immediate economic damages; social inclusion and social protection, e.g. by social security payments become dependent on private investment up front. The political emphasis is on employability through education at all levels in particular as the demand for "embodied education" brought into a firm by the employees ("purchased" human capital) increases, while in-house education decreases. Nonetheless social mobility decreases; access to infrastructure, income and education is increasingly dependent on parents' status, income and social networks.

Salaries are stagnating (in real terms, i.e. paying inflation compensation), but they are in effect decreasing per hour due to additional uncompensated working hours. A low income sector is established with no additional social security provisions. Due to forced saving for 'voluntary' private social security the disposable income is decreasing leading to increasing poverty and rapidly increasing precarisation. As income from transfers is minimised, dependence on paid work increases, even under bad conditions for access to goods and services, including health care and education. The income level of migrant workers from EU based on home country regulations (Bolkenstein Directive).

Income polarisation grows as there is no legal minimum income, permitting salaries frequently below social security payment (which is therefore lowered), with legal enforcement mechanisms (workfare) to make people work. At the same time, intra-corporation income distribution is approaching the extremes of current US habits with disparities exceeding the factor 100 (up to 1000 and more). As both tax and transfer policies

aim only for a limited modification of primary, market based income distribution (slimmed welfare state), the increasing income polarisation is accepted, and stakeholder acceptance enforced by control and repressive means.

Occupational health laws not enforced, often ignored, the work-life balance is no policy issue – work is ‘colonising’ all spheres of life with further flexibilisation, dismantling restrictions against 24/7 work day, and less paid holidays.

Agriculture (AFF) policies

Farmer are entrepreneurs, quantity, efficiency and world market oriented. Larger homogeneity on larger fields leads to less crop and landscape diversity. N deposition is high and pesticide use (more specific, more toxic) is increasing, limnic N deposition continues. All CAP production subsidies are phased out, but CAP still serves as supplementary source of income. The investment focus is on GM food as productivity and profit enhancer. New economic opportunities emerge from industrial raw material production, with high productivity and consequently few jobs.

In Forestry, short term income maximisation becomes imperative: fast growing species are preferred, the composition is market driven. Export oriented monoculture plantations with homogenous age structures are the economic ideal. In forest management, clear cut felling with heavy equipment dominates, while game feeding and hunting as sport and income source flourish.

The overcapacities and overinvestment in fishery fleets are maintained. Continued high catch rates cause collapses of an ever increasing number of fish stocks. Compensation is sought from high aquaculture production (with environmental problems of its own).

Environment policies

The relationship between economic growth, consumption of natural resources and the generation of waste changes slowly due to market generated productivity increases, waste volumes continue to grow faster than GDP. Quantitative reduction of material flows no main issue of environmental policies, except for energy carriers and waste management.

Climate policies focus on adaptation to moderate market fluctuations and exploit business opportunities arising from climate change impacts. Renewable energies are promoted as an export item, but domestically no fiscal incentives for efficiency beyond market mechanisms are introduced.

Watering down REACH in practice continues gradually by means of sloppy proofs, delayed registration of old substances. Biocide directive and pesticide policy remain unchanged and insufficient. Other EU directives (toxic waste treatment and disposal, Integrated Product Policy IPP, water framework directive, heavy metals emissions) and international agreements (e.g. on transboundary air pollution) remain in place, but are not extensively monitored and enforced. This credibility eroding policy serves to maintain obsolete structures and economic group interests, while civil society weakened, shared values are lost, and citizens’ disoriented.

Privatisation of the water sector is ongoing, followed by cost increases and abandoning of the “zero pollution” target. Strict health standards are maintained. The private water consumption is increasing as the water intensity of consumption is slightly increasing.

In nature protection the focus is on protected areas under the Natura 2000 program (Habitat and Birds directives) and the enforcement of the Ramsar, the Washington and the Bonn conventions, plus the protection of locations of national interest. Natura 2000 remains but is sluggishly implemented, with no additional protected areas designated.

Access to environmental information restricted, despite EU directive and Aarhus Convention, let alone to additional information.

Transport and mobility

The permanent increase in transport volumes and distances continues, overwhelming increasing technical efficiency and the effects of training and moral appeals. Long distance tourism is increasing, plus several short trips per year, with decreasing duration of each holidays. The extension of the road and airport networks follows increasing demand. As a result, the airborne N deposition from transport is increasing steadily.

Education and research/RTD

The rapid increase of privatisation of education institutions leads to some elite qualifications and – unintentionally – a deterioration of average general education. Specific training for employability will be offered, but using it will be personal responsibility. The participation of companies in professional education is decreasing.

The state continues its policy of providing a basic funding for research institutions as a means of competitiveness policy, with the bulk of project money coming from the industry. Both, business and public authorities focus on new products enhancing the international competitiveness of the national industry. R&D is used as a means of subsidising and industrial policy; the focus is on technical product innovations, cost reduction and labour productivity increases.

Besides ICT, research will focus on technologies such as biotechnology and micromechanics. Funding will be provided for research (but not for subsidising market entry) focussed on high technology, even if it has a low potential for new employment while making current jobs redundant, and despite the technologies are publicly disputed.

International relations: EU

EU enlargement ends with Romania and Bulgaria. The neighbourhood policy is based on strategic resource access and a dominance attitude. Conflicts and feuds arise, security is decreasing.

The transformation of the ACP cooperation into a market-based relation with very limited privileges, and a priority of trade over development cooperation is escalated further (if possible)

In the EU internal market, a tendency to harmonisation on the lowest common denominator emerges through the free flow of goods and services based on ‘country of origin’ principle.

International relations: Global

International policy orientations are shaped by a geostrategic (imperial) attitude to securing resource supplies and a global power projection based strategy. As economies are vulnerable to resource scarcity shocks, responses with economic and military means are prepared. ODA is low and an element of geostrategic planning.

Global free trade, including unsubsidised agricultural products, affluent countries focus on processing raw materials imported from the South and trade value added goods amongst themselves. Environmental impact of European economy, past and present, on Third World countries is no issue of concern in foreign and trade policies; the implementation of social and environmental concerns in trade rules strongly opposed. Compensations are only discussed as “package deals” in free trade and climate negotiations. Monetary and physical trade volumes increasing, with commodities and raw materials incl. drugs traded South-North, medium technology and weapons North-South, and the bulk of trade (in monetary terms at least) North-North, although first East Asia and then India become new hubs in the world economic system (Latin America and Africa stagnate). Environmental justice (Who carries the burden of environmental degradation?) is no issue of political concern. As a result, social and environmental debt accumulate. FDI is promoted, but often speculative

In monetary policies, the Washington consensus is maintained, with no regulation of financial markets, free floating currencies, high volatility and vulnerability

1.5 Outcomes

Climate change modelling assumptions and results

Regarding the relation to SRES, GRAS is rather close to A1FI in emissions and climate effect, as both are growth scenarios based on a neoliberal policy approach. With growth driving emissions, the Kyoto obligations are missed on the EU level.

A slow but significant sea level rise is expected along the lines of the IPCC projections; it is part of the already unavoidable trends but differs – in the long run – with the emission scenario and the model used. The EU member states are assumed to be preparing for it based on cost-benefit calculations. The same holds partly true for river floods, storms, precipitation change etc –measures like strengthening inland dykes have been taken, others are considered in case of urgency.

South-eastern Europe, the Mediterranean and central European regions are most vulnerable to climate change, with impacts strongest on natural and human systems that are already under pressure. Northern and some Western regions of Europe might reap some benefits from climate change, for some time. The strongest increases in storm intensity and frequency affect, in this order: UK and Ireland (10 more severe storms over a 30 year period, top wind speeds increasing by 8-16%), Netherlands and Belgium (more frequent storms, and top wind speeds increase up to 15%), Northern France (5-10 more severe winter storms over 30 years, top wind speeds up 8-16%, number of stormy days up 25-50%), Germany (Northwest) and

Poland (North) up to 50% more days with extremely high wind speeds and 10-15% higher maximum wind speeds.

Land use impacts

Agriculture may enjoy longer growing seasons and increasing plant productivity, but in the Mediterranean agriculture suffers due to water scarcity. In the beginning, this supports the linear increase of yields due to the development of new varieties (breeding and GMOs), estimated to be 1,5% p.a. until 2015, afterwards increasing to 1,7% p.a.

Socio-economic implications

The polarisation of income and the concentration of wealth in small segments of society is increasing as high incomes and capital gains are less taxed, while working poor are ever more frequent. Amongst the elderly, single parents and unemployed, poverty is endemic and politically accepted. The correlation of income, life expectancy and occupational health problems is significant.

Industrial relations are characterised by decreasing participation, with works councils acting as corporatist negotiators on the company level, with no relevant role for trade unions. Personnel rotation (fluctuation of the personnel) is increasing and thus job security decreasing due to labour law deregulation. The results are risks for the corporate memory on the company side, and for the employees patchwork biographies, no reliable future planning, and ongoing precarisation.

Energy consumption for climatising rises in the Mediterranean, which can cause problems due to reduced energy supply from hydropower and shortage of cooling water for fossil and nuclear plants. The total damage costs from increasing storms are unknown, but probably the annual average is less than 2 bio €/yr. In fisheries losses are expected due to changing migration patterns and reduced reproduction of fish. Additional economically relevant damages include tourism in mountainous and sub-arctic areas and due to heat waves etc

Biodiversity

The increase in physical trade and in tourism and the present trend in climate change reinforce the introduction and establishment of invasive species. This will cause biodiversity loss. Estimates of the control of damage costs of bioinvasions reach hundreds of billions of € in the year 2000 for the USA (EU studies are under way). However, such costs are considered marginal compared to the general benefits of *laissez faire* economic growth.

Fish stocks in European Waters have been near collapse; a number of stock will do so.

2 BAMBU – Business-As-Might-Be-Usual

2.1 Objectives

The basic orientation of BAMBU is improving the standard of living, with a strong emphasis on income and employment, but also including security and a healthy environment.

The policy strategy aims to reconcile environmental and economic objectives through efficiency improvements and instead to seek and realise the potential synergies between economic development and protection of the environment. In this way, structural change is sought to be directed in a way which accommodates economic growth, high employment levels, social cohesion and protection of the environment. In the EU, “the underlying idea of [the] Lisbon [process] is that a stronger economy will drive job creation alongside social and environmental policies that ensure sustainable development and social inclusion.” (Public consultation, Review of the EU Sustainable Development Strategy, SEC(2004)1042, p. 4).

To enhance efficiency, competition and the increasing volumes of international trade, financial flows and other elements of globalisation are welcome, but social and environmental framing is considered necessary. With respect to this, a balance of power must be sought between national and international institutions, e.g. within the EU and in its external relations. At the European level, better policy co-ordination will be pursued, but without significantly extending the competencies of the European institutions. At the national level, competition is stimulated by deregulation and privatisation except in “strategic areas”. Science and technology are considered to be the main drivers for competitive advantage as well as for environmentally benign processes of production and consumption, hence the emphasis on new technology developments. Internationally, free trade in particular in services is promoted, with a strong emphasis on the protection of intellectual property rights.

2.2 Ideologies and orientations

The EU Sustainable Development Strategy “puts major emphasis on coherent policy making and management of trade offs between conflicting objectives and interests”. To achieve this in the intended modernisation process as described by the Kok-Report and the revision of the Lisbon Strategy based upon it, highest priority is given to the improvement of economic efficiency (and also, partly as a side effect, to resource efficiency), and to innovation potential. Whereas the former results in a stimulation of markets and competition through partial deregulation (most often with the state in a supervisory role to prevent the economic actors from undermining competition by agreements or market power), the latter leads to an emphasis on RTD expenditures, human capital formation and life long learning. In the energy sector, most crucial for climate, both approaches prevail: while on the one hand new technologies (carbon free energy) is promoted, on the other old technologies are maintained and improved as far as possible (nuclear, coal, oil). One reason to do so is the protection of earlier investment, another the belief that a technological solution to the climate problem can be found (carbon sequestration).

Based on this trust in the capabilities of new and unforeseen technologies, the ageing society is predominantly perceived as a technological challenge, with relatively affluent pensioners as target groups for new intelligent products to be developed. Similarly, environmental degradation risks (including climate change) are mainly perceived as another technological challenge, providing the opportunity for developing and marketing efficient technologies nationally and abroad, as described in the Commission's 2004 Environmental Policy Assessment.

Gender mainstreaming is pursued, with reporting procedures and some quota as preferred means in an attempted persuasion strategy, focussing on "name, fame or blame" plus other incentives. The legal right to know practiced but not significantly extended. It permits the increasing use of publicly accessible data bases, but the success is limited by the digital divide. Business confidentiality is excessively interpreted, which limits control opportunities. Acceptance of regulations and public confidence is slowly eroding.

The public attitude is characterised by a mix of orientations for the private and the public good, by egoistic and social behaviour, by environmental and social consciousness and selfish lifestyles. Slowly increasing poverty and income polarisation is accepted, leading to social polarisation and tensions. A reduced social security is accepted, although based on transfers below the poverty line in most member states. Growing incomes permit growing consumption, limited by forced saving for private social security provision. With disturbances (economic, environmental, in particular social) further developing, feelings of uncertainty become stronger and precarisation increases, resulting in a strong risk avoidance preference (desire for stability). Trust in politics and voter turnout decrease. Intergenerational responsibility has a low priority in politics, but a higher one within families (intergenerational transfers). Voluntary activities are encouraged, in particular for the protection of natural and cultural heritage, based on some respect and appreciation for nature.

The focus on technology spills over into an material and technology intensive lifestyle, in some groups with preferences for short term fashion, in others for durable quality goods, and generally with high mobility.

Resulting policy hierarchies

The general idea of the BAMBU scenario is that policy decisions already made, but not yet fully implemented in the EU as well as in the member states, are in fact implemented and enforced. The basic concept of current EU politics (for more than 10 years, see the 'Delors Conferences' in the 1990s) is one of ecological modernisation of the European economy and welfare state. Thus, the latter is seen as something to be protected in particular in times of accelerating structural change, as it is a key tool to safeguard the social cohesion of European societies. However, to keep the cost of the social system in check, the public system of social benefit payments is restricted to fund a minimum income at or below the poverty level, and it will be conditional to individual life long learning efforts to enhance employability. Still some redistribution through the social security system is considered necessary. Social cohesion is an

important principle, but the policy approach shifts the burden from the state to civil society and social networks which suffer from the challenge. To stimulate investment and growth, taxes will be cut, resulting in reduced state expenditure in particular in social transfer payments. Nonetheless both social security and social cohesion are considered essential to the “European model”. However, the way they are provided changes by reducing public transfers (but still some redistribution takes place, although income polarisation increases), while as a compensation encouraging people to complement it with market based private risk coverage.

Sustainability strategies are tools to promote this multi-pronged objective, and sustainability indicators are introduced to report progress. The EU Sustainable Development Strategy “aims to achieve a better quality of life for everyone, now and for generations to come. Its basic aim is to ensure that economic growth, environmental quality and social inclusion go hand in hand, thereby increasing citizens’ welfare” (ibid). To achieve this, the state intends to set reliable, long term framework conditions for business, including moderate eco-taxes and the reduction of labour cost to enhance employment. They will be negotiated by corporatist networks or as voluntary agreements with the state as a moderator. In this respect, Public Private Partnerships PPP will play an increasing role. Integrated assessment is developed but hardly applied, but EIA and SIA are routine procedures.

In a number of cases, sustainable development requires politics to correct market results (e.g. by internalising environmental and social costs) or to correct policy failures (e.g. by placing a stronger emphasis on environmental and social issues in the revised CAP, the next phase of the structural funds, or slowly reducing the fishing quota). However, the principles of a liberal market economy and the EU regulation modes (including the Common Market) set rather close limits to any such intervention. In all such cases, however, putting a burden on business is avoided as much as possible, and win-win solutions as an element of a pain-free transition strategy are the preferred pathway to implement sustainability strategies.

These efficiency enhancing strategies must be designed and enforced within a policy framework aiming at public acceptance, and including measures for the promotion of social inclusiveness, thus generating a double or even triple win criterion for policy strategies towards sustainable development. Public acceptance is stimulated by participation mechanisms and access to environmental information, social reporting strengthened participation of some subgroups of society by new technologies such as e-governance and e-democracy. The representative democracy is strengthened in all EU member states, but the dominance of administration against parliamentarian control in EU (Council) and most member states continues. Participation opportunities are maintained, but are unbalanced due to the influential role of strong professional lobbies. In the EU, inter-institutional coherence, policy coordination and the effectiveness of institutions are to be enhanced by effective subsidiarity and administrative reform

The correlation of income, social position and exposure to environmental risks is underestimated. Disaster preparedness is considered an administrative task, with an important role for civil society. Efforts to fight against/combat corruption are ongoing, but with limited success although measures against crime increasingly coordinated, with some success.

Increasing simultaneously conflict prevention and pursuing a geopolitical approach leads to limited credibility in countries of the South.

2.3 Trends

Demographic trends (incl. labour force participation)

Population growth in the EU average is small but positive (stable birth rates, slow increases of life expectancy, limited migration from outside the EU), with wide differences between countries. Inside the Union, migration from East to West peaks (before 2005: +0.1% p.a., 2005-2015: +0.15% p.a., after 2015: +0.1% p.a.) with a preference of intra-country migration to small and medium sized cities, including teleworking and commuting.

Increasing flexibilisation of social security provisions and retirement regulations leads to greater labour force participation of women and elderly despite unemployment.

Settlement structures

Urbanisation continues, in particular in Central Europe, supported by a policy preference for compact city development and compact peri-urbanisation. Mobile and teleworking increase commuting (by public transport on main routes), with limits from transport costs. Due to the migration pattern, the GDP of small to medium cities grows + 1% p.a. above the national average; big cities and countryside decrease accordingly.

EU Regional Policy is focussed on continuing payment to less favoured regions, with a shift of focus to the new member states. Funds are conditioned, focussed on economic development, with social and quality criteria as framework and IA for major plans and policies. National regional planning includes securing leisure opportunities, nature protection etc., but the dominance of economic interests is unbroken. This results in a stabilisation of land use intensity including a reduced rate of sealing soil, but the pressure from transport infrastructure demand (mainly roads) continues. The location of agricultural areas based on rent maps plus minimum standard for agricultural activity: no less than 12% where today agro-workforce share is > 20%. Compensation for economic losses due to vegetation shifts, changes in migratory patterns of birds and fish redefining the value of hunting and fishing rights to moderate distributional conflicts are paid but remain limited.

2.4 Politics

Economic policy

The objective of economic policy is competitiveness, leading to job creation by surplus generation and domestic consumption. As means for this end, an instrument mix with rather patchy orientation (muddling through) is implemented. The mixed bag includes measures to attract FDI, but also restrictions. Partly deregulation (with limits due to public acceptance) and privatisation (publicly owned corporations and utilities in the fields of transport, communication, energy and water, but with state control boards and authorities setting standards and controlling prices; schools and health care partly excluded) create an economic

and political environment favourable to enterprise (TNCs and SMEs), encouraging investment and innovation, enhancing consumer and investor confidence (although market entry barriers remain). Search for win-win solutions, based on CBA, dominates several policy fields. Liability regulation allocates the cost e.g. of risk assessments, damage detection and repair according to the polluter pays principle, with exemptions.

In principle, the primacy of policy prevails in target setting, but politicians have a strong emphasis on acceptability to business in target definition. Thus only restrictive use is made of state interventions, but for strategic reasons some are considered necessary; for instance, due to a preference for market-based instruments, government procurement is used as a competition and innovation enforcing policy, with growing but limited European integration. Little voluntary investment of time and human resources for the public good is expected, business will not replacing the state due to its basically different orientation towards the private good, and the resulting lack of legitimacy.

Fiscal policy

While resource and consumption taxes increase, capital and business tax decrease. However, the corporate tax level decrease is phased out slowly: while nominal rates fall, effective taxation reductions come to an end as loopholes are closed. Politics is promoting consumption to enhance growth, tax revenue and employment.

Some subsidies are abolished (mainly in the primary sector, agriculture, mining), but partly replaced by new ones (like biofuels), social transfers and compensation payments. The total level is slightly decreasing (rather stagnant if compensations are taken into account).

No regulation of financial markets occurs, but policy coordination is suggested to limit currency speculation. The Bretton Woods institutions dominate with little change in paradigm.

Energy policy

Energy price trends are assumed based on the (rather low) assumptions of the 2004 International Energy Agency IEA cost scenarios (the 2005 scenarios predict a higher price, but the same kind of trend: declining energy prices in the short run, gradual increases due to higher production costs in the long run), and raised by a constant factor of 1.5.

A stepwise nuclear phase out occurs in most EU countries for environmental and cost reasons (nuclear armed countries maintain nuclear power plants). Energy taxes remain rather low (including the EU level emission trade), but renewables are supported, despite liberalised markets (but with competition control). Starting point was the 0.3% biofuel share in gasoline in 2005, with targets of 2% in 2005 and 5.75% in 2010, although 12% renewables in total energy production require 130 Mtoe biomass. While maintaining the priority to security of food supply (food autarky), changes of the agricultural production and financing pattern are envisaged. Waste and lingo-cellulosic material provide limited contributions, with the vast majority being bio-diesel and bio-ethanol (requires less area, as CH₃OH & ETBE) from agriculture-derived feedstock.

Social and employment policies

The new European model of the repressive welfare state develops further. The new welfare state provides social security payments below the poverty line (transfer incomes are reduced, but a minimum is still available), with the obligation to take any paid work available regardless of qualification discrepancies and salary levels (forced work). Access to the social security net (reduced for cost saving reasons) will be conditioned, excluding those not willing or able to participate in lifelong learning.

Social mobility decreases gradually as salaries determine access to goods and services. Access to infrastructure, income and (higher) education depends on individual performance and resources (including the kind of work and the salary), but is supported by equal opportunity policies. Social networks can compensate for reductions in welfare state performance for some time, but begin to degrade under continuous pressure.

Gross and net salaries are increasing with a rate below productivity development but above inflation rate, but in effect the hourly payment is stagnating due to uncompensated extra hours; the stagnating holidays are not fully exhausted by employees. Current intra-corporate income level disparities (factor 70-100) increase, but slowly. A low income sector is established, with public income support. Minimum incomes guaranteed by legislation or industrial contracts. The minimum wage is slightly higher than social security payments, but often below poverty line and not always enforced. Thus while poverty is stagnating, precarisation increasing as the limited purchasing power increases are compensated by obligatory private social security payments and increased saving due to feelings of economic insecurity. Voluntary work is encouraged. Regarding the status of inner-EU migratory workers, a compromise is sought: social security payments are paid directly by the employee (no employer contributions), resulting nominally in salary levels between home and host country.

Occupational health and safety standards are not further developed, but implemented. The work-life balance tipped towards integrating work in all spheres of life.

Agriculture and AFF policies

Production is for the global market, divided into bulk and high quality segments, but the increase of productivity in mono-cultures is slowing down. Financially, agricultural policy is phasing out production and but not all export subsidies and maintaining social transfers. New income is generated from biomass production for from renewable energy, some from GM food, some from organic agriculture.

The CAP supports agro-environmental measures, e.g. by payments for landscape maintenance, but nonetheless intensive agriculture prevails, with no changes towards higher landscape diversity and less agrochemicals. Consequently, N deposition and pesticide use are stabilised, but nitrogen saturation of soil leads to groundwater contamination. Limnic N deposition is only slowly decreasing.

In Forestry, proactive planning leads to planting climate adapted species, domestic and imported, in mixed age classes. Size limitation to clear cut felling and equipment is

introduced for erosion prevention. Virgin forests are protected, the Natura 2000 habitat networks are implemented. As game is a source of land owners' income, measures against overgrazing are taken.

In fisheries, some conservation policies are in place with the aim to stabilise current fishing volumes. Nonetheless some stocks collapse, few recover, and there is little improvement for long-term conservation.

Environment policies

The relation between economic growth, consumption of natural resources and the generation of waste changes, driven by policy measures (resource strategy), which stop the trend that waste volumes have persistently grown faster than GDP. Material flow management aiming at decoupling of economic growth and resource consumption leads to decoupling mostly in relative terms plus sound management of natural resources (EU SDS), but the economy remains vulnerable to resource price shocks and resource conflicts. On the output side, waste minimisation focuses on recovery and recycling.

Promotion of renewable energies and some support for resource productivity increases (limited for competitiveness reasons). A focus is on energy efficient technologies, CO₂ sequestration and adaptation to climate change incl. disaster protection, stepwise integrating social and environmental research.

REACH is slowed down but implemented, with strict controls. A gradual replacement of old substances takes place, but deficits like coverage of the release of medical substances into the environment remain. Biocide directive and pesticide policy, now up for review, are upgraded, clarified and their enforcement is controlled by the Commission. Other EU directives and international agreements extensively monitored and enforced. Parts of the chemical industry relocate to emerging markets, while those remaining in the EU switch to speciality chemicals (structural change, balanced budget). The number of deaths caused by chemicals is decreasing. Technical progress considered as main repair mechanism.

The EU is striving for high water quality above strict standards, in particular through enforcement of the Drinking Water Directive on all agents in the mixed system of private and public ownership. The Water Framework Directive implemented. Private consumption per capita is slowly increasing in Europe, but the water intensity stagnates.

In nature protection, the Natura 2000 habitat network is extended with national and regional sites. However, there is no systematic protection outside designated areas which – together with the development of agriculture – accelerates the trend towards biodiversity islands within an ecological desert. Some of the driving forces of bioinvasions are somewhat tamed (taxes on air travel, relative dematerialisation of the economy and stronger emphasis on local resources, slowing-down climate change). For the rest, control measures (directed towards specific “weak-link” countries), and also prevention against bioinvasions based on CBA are pursued.

Strict implementation of EU directive on information access and Council of Europe Convention is happening across the EU, with some countries offering more than others to their citizens (via internet).

Transport and mobility

Road pricing and levies on city driving (London model etc., with EU-wide standards for such levies) are introduced to limit road transport volumes and commuting by car, but reduced in effect by the extension of road, canal and rail networks. As a result of the mixed measures, supported by eco-taxes, information, etc., transport growth continues but is slowed down (the duration of holidays is stabilised).

Kerosene tax remains low, budget airlines are still booming. Technological measures keep airborne N deposition from transport constant despite growth in transport.

Education and research/RTD

Qualification demands are high, but limited and stagnating willingness of companies to provide in-house education limits skill availability, despite public support for technical education to provide an educated and trained labour force. Employability key concern in public policy; education and training are the core means to enhance employability. While the increase of privatisation is slow, the excellence-driven segregation of public educational institutions continues. Qualification efforts will focus on higher education, and the management and engineering faculties will receive special support.

Public and private research funding increase, the latter encouraged by tax breaks and other policy means. Public funding is a means of competitiveness policy for the benefit of national resp. the EU business sector, shaped by its focus on technology promotion, concentrated on pre-competition research with a clear orientation towards product development. Social sciences and humanities will continue to decline.

European corporate RTD expenditure is still lower than those of competitors, and focus on product quality improvements and new technologies (nano, materials, genetic engineering). Industrial policy supports entrepreneurs, but also supports sunset industries despite negative environmental impacts.

International relations: EU

The EU enlargement continues, including pre-access agreements with Turkey, Ukraine and Balkan countries. Neighbourhood policies with Russia, Mahgreb and Near East countries are double edged, comprising cooperation and confrontation and pressuring partners to accept the EU rules and regulations.

The dominance of economic motives and instruments in ACP cooperation as part of the WTO rules continues, but is complemented by strengthened development cooperation, anti-hunger and health support programs.

While the EU internal market is partly harmonised on lowest common denominator, exemptions for protection sectors of public interest are made.

International relations: Global

Foreign policy focusses on the EU proximity as sphere of influence, including Russia, Mahgreb and Middle East from Saudi Arabia to Caucasus and Central Asia through the EU neighbourhood policy. The EU continues playing geopolitical chess games, complemented with some longer term agreements based on economic interest. The means are a combination of development co-operation (FDI and ODA continue), strategic alliances, political pressures and military threats. The stability of results of this partly contradictory policy mix remains fragile.

In trade, WTO rules prevail, but the room for manoeuvring regarding social and environmental standards is fully exploited. Physical trade volume increases South-North, monetary volume increases North-North. There is moderate support for integrating non-economic concerns, e.g. tolerance of labelling, but opposition to taxes and import restrictions based on other than production cost criteria remains. Monetary and physical trade volumes are increasing, with commodities and raw materials incl. drugs traded South-North, medium technology and weapons North-South, and the bulk of trade (in monetary terms at least) North-North, although first East Asia and then India become new hubs in the world economic system (Latin America and Africa stagnate).

Environmental justice is discussed as ecological and sustainability debt accumulation between North and South, only symbolically addressed in trade and climate negotiations, but emerges as one focus in development cooperation, with a dominance of ad hoc solutions.

2.5 Outcomes

Climate change modelling assumptions and results

The climate trend is close to the SRES A2 scenario characterising the past emission trajectories due to the time lags between emission and the climate impact, although regarding the emissions BAMBU is not an A2 world as described by the IPCC. The EU pursues a policy objective of -20% CO₂ by 2020 and pressures for international cooperation in a Kyoto 2 agreement.

A slow but significant sea level rise is expected along the lines of the IPCC projections; it is part of the already unavoidable trends but differs – in the long run – with the emission scenario and the model used. The EU is assumed to be preparing for it based on cost-benefit calculations and precaution. The same holds partly true for river floods, storms, precipitation change etc –measures like strengthening inland dykes and adapting forest management to increasing top speeds of storms have been taken, others are under preparation.

South-eastern Europe, the Mediterranean and central European regions are most vulnerable to climate change, with impacts strongest on natural and human systems that are already under pressure. Northern and some western regions of Europe might reap some benefits from climate change, for some time.

The strongest increases in storm intensity and frequency affect, in this order: UK and Ireland (10 more severe storms over a 30 year period, top wind speeds increasing by 8-16%), Netherlands and Belgium (more frequent storms, and top wind speeds increase up to 15%), Northern France (5-10 more severe winter storms over 30 years, top wind speeds up 8-16%, number of stormy days up 25-50%), Germany (northwest) and Poland (north) up to 50% more days with extremely high wind speeds and 10-15% higher maximum wind speeds.

Land use impacts

Agriculture may enjoy longer growing seasons and increasing plant productivity, but in the Mediterranean agriculture suffers due to water scarcity. The technology induced linear agricultural plant yield increases slow down, from 1,5% p.a. until 2015 to 1,3% p.a. afterwards.

Fish stocks in European waters have been near collapse and only a part recovers slowly.

Socio-economic implications

The total damage costs from increasing storms are unknown, but probably annual average less than 2 bio €/yr. In fisheries losses accumulate due to the climate-induced changing migration patterns and reduced reproduction of fish, partly affected by marine pollution. The most economically relevant damages – aside from health cost – include tourism in mountainous and sub-arctic areas and reductions of Mediterranean tourism due to heat waves etc. Energy consumption for climatizing rises in the Mediterranean, which can cause problems due to reduced energy supply from hydropower and shortage of cooling water.

Income polarisation is stabilising as high earners and capital gains are relatively less taxed, but the tax structure is still progressive. The further dismantling of social security makes working poor a persistent phenomenon. Patchwork biographies with unemployment and education phases between jobs become the new norm, and a reason for ongoing precarisation.

In industrial relations, the “industrial partner policies” continue, with business the stronger partner. Trade union organisation levels slowly decrease, but some European coordination with the social competencies of the Unions takes place as foreseen in the Constitution.

Working relations are rather stable (due to high unemployment workers do not dare to leave, regardless of the working conditions, and due to the skills shortage employer tend to keep them). Job losses occur mainly due to restructuring, the total size of the labour force is shrinking. Women are encouraged to join the labour force by gender mainstreaming measures.

3 SEDG – Sustainable European Development Goal

3.1 Objectives

The SEDG scenario is primarily oriented towards increasing the quality of life, comprising economic factors such as income and employment as much as social factors (networks,

relations, health) and the services gained from a benign environment.⁶ Quantitative surplus is neither considered as negative, nor as a substitute for qualitative gains: less (e.g. materials throughput or working hours) can be more (in particular quality of life). Consequently, a significant reduction in material flows, conspicuous consumption and working hours is sought. The policy focus is not on economic growth as such (as an indirect means to combat the sustainability problems of society is emphasised), but towards strategies to directly deal with the problems identified (e.g. environmental degradation, unemployment, a lack of distributional justice or gender justice, poverty, etc.), with growth occurring as a side effect. Not achieving a maximum, but a balanced optimum is the overarching orientation. This attitude of economic actors is based on an evolution of individual attitudes towards social behaviour, environmental consciousness and high esteem for the public good.

The scenario aims at a long-term stabilisation of climate and general environmental conditions as a condition for a sustainable socio-economic development. Reducing the increase of GHG is a policy priority, with the aim to reach stabilisation earlier and on a lower level than in other scenarios. The target value of stabilisation at 450 ppm is considered desirable, but not realistic; thus a stabilisation at 550 ppm is a policy objective for domestic and foreign politics.

The sustainability of societal development is furthered by an integrated social, environmental and economic policy. Objectives are a competitive economy, social cohesion, self-realisation opportunities and capabilities, a healthy environment, gender equity and European as well as international development co-operation. Governance will be improved by enhancing transparency through technical and organisational means and by involving civil society groups in the decision process.

This requires long term reliable policy conditions based on a consensus that is as broad as possible, an intelligent combination of informational, economic and command-and-control policy instruments including voluntary agreements ('agree-and-control'), labelling, eco-taxes, and proactive health and safety standards.

Capability for political action requires a number of means to be in public hands, such as some shares in certain businesses, regulations and obligations, re-regulation with the intention to make regulation more effective and efficient, deregulate where regulation has become superfluous, but also introduce new regulations when necessary.

At the European level, this implies a deeper integration of more policy fields and a reform of the Union structures to enhance effective and efficient decision making, policy integration and a stronger role for the parliament. Furthermore, significant funds are made available for the integration of Europe, for the accession countries as well as for collaboration with the Mediterranean and East European neighbours. Development cooperation receives greater

⁶ The standard path in the model cannot be modified to reflect working time policies for full employment. Alternatively, the expected additional employment per country has been externally set, and the economic results calculated. Labour force participation is possible to indicate, based on past data as starting point, and extrapolated.

emphasis, including a coordinating role in the definition of external trade, economic and foreign policies. Internationally, agreements for social and environmental standards are sought (global governance).

The ageing society is perceived as a political challenge, calling for social innovation (integration and cohesion) as much as for technological innovation (regarding health, housing, etc). Such an adaptation is accelerated by the increasing energy prices due to political intervention, which have an impact on the urban development and settlement patterns. High energy costs tend to reduce long-distance commuting, and the comparably high heating costs for single houses support the move “back to the cities”. This leads – at least in the medium to long term –to settlement patterns characterised by more compact urban structures, less suburban population and an end to urban sprawl.

Rather obviously, such a change of trends would generate significant positive impacts for biodiversity.

Proactive social policies are a constitutive element of the sustainability course, providing protection against life risks such as unemployment or bad health well above the poverty level, although additional private savings are still welcome. Pensions are intended to preserve the standard of living achieved during the active working life. This requires a reversal of the income distribution trends, towards a functional income distribution more similar to the 1970s or 1980s.

State income increases due to taxation of environmental “bads”, and the money will be spent on improved social security including poverty eradication, environmental protection investments and education and research. Life long learning opportunities will be provided with appropriate incentives.

3.2 Ideologies and orientations

Market mechanisms are considered one important, but not in all cases the most adequate mode of regulation. Market failures (failing in efficient allocation, e.g. by ignoring social and environmental costs) and market system failures (failing to allocate goods according to other criteria than purchasing power, where this is the political preference) are acknowledged. Political intervention to correct such failures is accepted and the respective EU regulations are adapted to this orientation. The acceptance of regulations and public confidence is improving.

For instance, increasing mobility of goods and people is perceived as a challenge and restrictions to long haul lorry transport are implemented together with economic incentives for using more environmentally sound modes of transport. Other economic instruments would to some degree “internalise the external cost” of transport, thus discouraging all kinds of long distance transport and supporting regional production and short to medium distance exchange.

An immaterial style of consumption emerges, with preferences for durable quality goods at adequate prices, high technology and high mobility. The capability to buy such goods is limited by purchasing power restrictions resulting from working time reductions.

Checks and balances are introduced to enhance openness, transparency, and accountability. The legal right to know extended and practiced. Investment in informed decisions (data bases, public research, monitoring systems) increases, resource provision for civil society and citizens' information and participation is institutionalised.

Gender equity is enforced, e.g. by means of quota, conditionalities for funding, promotion etc. Proving caring capabilities and experiences becomes essential for male careers.

Distributional justice is an important concern to citizens and administrations alike, respect and appreciations for nature, its management and cultivation. As policy follows these preferences, trust in politics is improved due to enhanced transparency and accountability. With less social tensions, a sense of place, historical and emotional values grows, maintaining identity values (patrimonium) beyond consumption. A risk taking attitude is growing, based on the reliable backing individuals receive from social networks and public transfers ("can afford" attitude) and on a feeling of cultural security.

Resulting policy hierarchies

The main political decision capabilities rest with the state and trans-national bodies such as the EU; their responsibility is explicit and includes issues of equity and justice, legitimacy and accountability. Issues of power distribution and spheres of influence are an explicit issue in sustainability transformation strategies, and a balance of power is called for. Participation processes are supported in politics, the business sector and civil society. Citizens' involvement is acknowledged, but does not replace responsible decision making (no veto rights for individual groups). The accountability of policies is strengthened by direct democracy elements integrated into the representative democracy, with a significant improvement in transparency and access to information.

The effectiveness of institutions is enhanced by more openness, inter-institutional policy coherence and policy coordination. Subsidiarity and local responsibility strengthen citizens' participation. Enhanced transparency supports a lack of bias and reduces the influence of vested interests, helping the effective fight against corruption. The precautionary principle applies in security against crime.

Impact assessment, from EIA to IA, for policies and innovations, and liability laws based on PPP (polluter pays principle, full costs) reduce risks and contribute to the freedom from natural and man-made disasters. Protective measures minimising the impact in case disasters cannot be avoided or minimised are taken, with an important role for civil society.

Win-win solutions are welcome and considered a necessary first step to be taken, but the need for more controversial steps is acknowledged. Winners and losers will exist, and one element of a transition strategy is to identify them, motivate the potential winners and offer transformation support to create more of them. For the losers (companies, regions, etc.) policy measures to buffer shocks and minimise social hardship (compensation packages) are defined. Socially and internationally peaceful conflict solution is sought

3.3 Trends

Demographic trends (incl. labour force participation)

The population development is slightly positive (life expectancy slowly increasing, birth rate growing but still very low) including some accepted refugees, asylum seekers etc., leading to low but continuous population growth. Migration into the EU increases but is still limited, inside the Union the migration East to West phases out due to improving living conditions in Central Europe (before 2005: +0.1% p.a., 2005-2015: +0.15% p.a.. after 2015 no net migration). For similar reasons, migration between cities country side is balanced.

Flexibilisation of pension regulation permits some people to work longer, but the preference for retirement at the age of 60 dominates.

Settlement structures and regional development

Urbanisation goes on, with compact city development in particular in Central Europe, plus support for rural life and economy. Mobile and teleworking grow in some sectors, reducing commuting and improving rural life. Due to the phasing out of net migration, the spatial income distribution remains rather unchanged and the transport demand in rural areas is reduced, with improved public transport in cities.

The EU Regional Policy is strengthened by an increase of payments to less favoured regions up to 1% of the EU GDP, however under strict control of conditionalities of sustainable regional development and with IA applied to planning on all levels, with strict standards. This includes reduced land use intensity, bringing sealing of soil to a standstill, and a proactive approach to land use planning for landscape and nature protection including biodiversity preservation, and for social concerns. A slow decrease of areas under use (due to productivity), rather evenly spread (diversity of landscapes taken into account), is the result.

Prevention of and adaptation to impacts of climate change and other environmental pressures are a political priority. Hunting and fishing rights are used as tools to enforce sustainable resource management on users (quota systems etc.) and thus avoid distributional conflicts.

3.4 Politics

Economic policy

In SEDG the primacy of policy in target setting is realised. The economy is a mixed sustainable market economy. The economic policy objective is macroeconomic stability of a competitive innovative knowledge economy with balanced trade. The social and political environment is favourable to enterprise (focus: SMEs, cooperatives, social economy), investment, entrepreneurship, and innovation. Market entry support intensifies competition and avoids the emergence of oligopoly structures (existing ones are dismantled). Strict measures are taken to prevent monopolisation and market power abuse. By liability regulation the cost e.g. of risk assessments, damage detection and repair caused globally are allocated according to the polluter pays principle, with strategic exemptions. More competition under

changing price relations caused by resource taxation cause an innovation push offering more sustainable satisfiers for human needs. This is enhancing consumer confidence.

Industrial policies focus on proactive measures (climate change), economic stabilisation and disaster protection. Transdisciplinary integrated assessments are mandatory for all major projects, from the RTD stage. Policies prefer an effective and efficient instrument mix of market-based, legal and planning instruments, with flexible regulations and voluntary agreements (achieved by agree & control measures). Voluntary environmental and social activities at company level are encouraged, like CSR and EMAS, if they go beyond compliance. Investment of some time and quality human resources for the public good is obligatory, operationalising the social responsibility of business.

Complementing the market a workable public sector is maintained (not broad privatisation), covering the fields where allocation according to purchasing power is considered inappropriate (e.g. public schooling, health care, water supply). Publicly owned enterprises are considered as strategic asset for politics, for instance executing market power through their procurement policies.

Policy is promoting sustainable consumption by information (labelling durable goods), by product standards (top runner approach) and by enhancing the freedom of choice. Reducing resource dependency by enhanced efficiency and by resource use capping limits the risk of price shocks and avoids conflicts over resource access.

Fiscal policy

Corporate tax levels are slowly increasing up to the early 1990s level. The overall tax base is shifted away from labour to resource consumption (energy, material, land) and capital, speculation, and environmental pressure factors such as transport. Material flow taxes make the transition towards dematerialisation and energy saving more affordable, the revenues are spent as support for renewables. Resource input taxation is harmonised with output regulation (standards, capping). European tax harmonisation is progressing along these lines; a progressive income tax is the EU standard.

The European subsidy system is reformed: outdated subsidies are phased out, socially and environmentally useful and effective ones maintained with updated criteria, objectives and monitoring. New ones for the sustainability transition incl. specific VAT breaks are introduced, but decreasing over time, with limited duration and under regular assessment. As a result, the total level of subsidies is declining significantly.

A global (Tobin) tax enhances the resilience of the international financial system, and the European tax system is adapted to prevent tax evasion (country of HQ principle).

Energy policy

International energy price trends are assumed based on the rather low assumptions of the 2004 International Energy Agency IEA cost scenarios (the 2005 scenarios predict a higher price, but the same kind of trend: declining energy prices in the short run, gradual increases due to

higher production costs in the long run). Domestic prices in Europe are raised by a constant factor of 2.0 to encourage energy saving and invest into renewable energies.

The EU plans a continuous increase of the renewable share in energy consumption from 20% in 2020, requiring 210-250 Mtoe biomass. The environment and biodiversity compatible potential is estimated to be 180 Mtoe in 2010, and 300 Mtoe in 2030 (from waste, forestry and agriculture, forest = lingo-cellulose). This assumes 30% environmentally-oriented farming 2030, additional set aside land, selection of locally adapted bioenergy crops, unchanged protected area, residual forest removal and complementary fellings, waste minimisation and stringent climate policies.

For full exploitation, the price of CO₂ avoidance would have to be 30 €/t 2010 and 65 €/t in 2030; without, about ¼ less production results (the difference is agricultural land where food and fodder production has been replaced by biofuel for cost reasons). A progressive energy tax supports the full use of the sustainable potential; overshoot is avoided by environmental regulation. An accelerated nuclear phase out takes place in most EU countries as the cost of renewables undercut the cost of nuclear, with low upfront payments and less capital fixation.

Social and employment policies

Intergenerational justice is promoted by investment in education and environment. The maintenance or improvement of human capital is supported by a range of means and mechanisms. For instance, in-company training becomes a more attractive investment for employers and employees since the return on such investment is high as worker turnover is low due to better protection against firing. Seminars and workshops are offered by public education institutions, mixed professional education (school and company) enhances labour market relevant skills, vocational training during working hours supports the introduction of new technologies and management models, one or two weeks of educational holidays (including personality development other than training for the job) are a legal entitlement for workers and employees. Health and safety training is intensive, new standards are set by the EU (EU competence as foreseen in the draft Constitution, but released from constraints).

Decreasing length of work days and additional holidays, with wage compensation, improve the work-life balance and remove obstacles to voluntary work; this is encouraged and supported e.g. by recognising such activities in the calculation of public pensions (which dominate the social security system).

The salary development is productivity oriented, partly paid out as increased paid leisure time. Policies support closing wage gaps; in particular caring sector salaries are brought closer to national average⁷. Host country conditions binding for all those working in the respective country (like for qualification). This is possible as much of the health care sector is under public ownership. However, on average the purchasing power is growing only slowly due to shorter working weeks; disposable income grows somewhat faster as there is no need for

⁷ Caring jobs are – like all „typically female“ occupations – significantly worse paid than the average job. As in an ageing society the demand for such services increases, this salary discrimination is not only unjust but also counterproductive.

additional private insurance. Salaries dominate welfare, but complemented by basic income above poverty line.

To overcome poverty, reduce income polarisation and increase purchasing power a minimum income is guaranteed by legislation or industrial contracts. Together with progressive taxes on income and wealth this leads to a relatively flat intra-corporate distribution, about a factor of 10 to 20 (the current Japanese standard), significantly lower than today but higher than in Europe in the 1960s/1970s. The minimum is slightly higher than the tax based basic income (above national poverty lines, i.e. eradication of poverty), for instance in the form of a negative income tax. Thus no poverty remains (based on 2005 income distribution); precarisation is decreasing due to a secured monetary basis for planning the individual life. Social mobility improves education, health care and other public goods provided as merit or public goods are accessible to all income groups.

Agriculture and AFF policies

For agricultural policy, the transition to ‘environmental protection and social cohesion’ is the overarching objective, rather than ‘world market competition’. The focus is on high quality segments, there is no legal permission for GM food. Land of poorer quality extensively managed.

Accordingly there is a much higher share of agro-environmental expenditures in the CAP budget (with no option to redirect it to the first pillar). Agro-environment schemes consistently monitored, resulting in better agricultural and wildlife biodiversity, and higher landscape diversity. This results in significant reduction of N deposition from land use; limnic N deposition is reduced below critical thresholds.

At the farm level awareness is emerging favouring organic agriculture, resulting in a temporary drop in productivity, followed by slow increases, and buffered by social transfers. Additional income is generated from tourism (helped by the phasing out of pesticide use) and from industrial raw material production, with bio energy coming mainly from waste material (the sustainable biomass potential is exploited but not mainly for energy).

Sustainable forestry management focusses on developing climate adapted forests with mixed domestic species (conifers and deciduous tree) including unmanaged enclaves. Natural rejuvenation is revitalised due to reduced stocking of herbivorous game as game populations limited to natural level, feeding and hunting only permitted for regulatory purposes. Harvest is undertaken by soil compression free single tree extraction, e.g. by using horses for tree extraction. Virgin forests are protected, Natura 2000 sites are managed properly and habitat networks beyond NATURA 2000 are legally protected, including extended migration pathways as a climate change adaptation measure.

Restrictive conservation policies in fisheries (fresh water, estuary and marine) with eco-system-oriented management, protection of juvenile stocks and technical measures to reduce bycatch lead to a slow recovery of most but not all fish stocks.

Environment policies

Dematerialisation is pursued by a range of policy measures including resource use and material input taxation (MIT), modified mining licenses, and the adaptation of taxes. To business, the MIT set to act as stimulation for systematic scrutiny of production processes, rather than as an economic incentive as reducing resource consumption is already economically beneficial. To consumers it signals the value of resources and the need to use them sustainably, giving an economic incentive for the purchase of durable and repairable goods. Product labelling wide spread, with consumers taking care. The objective is to reduce the physical throughput in absolute terms, i.e. to slim the economy to achieve a factor 10 reduction of resource extraction (measured at the borderline of bio- and anthroposphere), thus decoupling economic development (not necessarily growth) from natural resource consumption and waste generation. Dematerialisation of production and immaterialisation of consumption minimise resource consumption and waste generation and help preventing resource availability crises by reduction of demand. To reduce the share of resources which is released from the economic system as waste, recycling is promoted on all levels by technology, education and waste fees.

REACH is improved by making it applicable to substances for export, rapid phasing out of old substances, and stricter criteria. According to them, biodegradation pathways and detection methodologies in the environment must be published and proven for the expected product distribution scale and life time.

Other EU directives and international agreements are extensively monitored and regularly updated (like the Montreal protocol), and then enforced.

Emphasising the “zero pollution” target for drinking water, public control of water provision for fair, high quality water supply is strengthened, and significant reductions in water consumption are achieved by means of pricing and efficiency standards. Private water consumption is stabilised or slowly decreasing, water intensity of the economy (agriculture, power plants) is decreasing significantly due to reduced water loss by updated and upgraded technology (transport loss, irrigation systems, closed loop cooling,...). The Water Framework Directive is fully implemented before time.

Nature protection is understood as a full scale land use planning task: sustainable forestry and organic agriculture combine with extended Natura 2000 and other habitat networks to support adaptation and the recovery of rural biodiversity in formerly intensively farmed areas. International biodiversity protecting Conventions are enforced.

Actions are taken to reduce the driving forces causing accidental species invasions are. Apart from this, the very concept of “bioinvasions” is deconstructed. A general bioinvasions policy is discarded. Political, stakeholder based assessment of the cons (and pros) of specific invasions – with emphasis on adaptation – is systematically introduced. Vigorous control and effective mitigation measures are taken only in some cases.

Strong civil society involvement is supported by access to (so far confidential) information, e.g. internal risk assessments, and to public information like pollutant emission registers.

Transport and mobility

Dematerialisation policies including resource-taxation and land use charge will automatically lead to decreasing bulk hauling, with preference for the remaining transport needs growing for rail and ship due to general road pricing (on motorways and in cities, in particular for heavy lorries) and improved rail networks (no further deepening of rivers).

For air transport, there will be limits to available slots, and flights <1000km will be an exemption. A kerosene tax ends budget flights. New technologies, efficiency and curbing transport growth combine to reduce airborne N deposition from transport significantly.

Long distant holidays are made only occasionally due to cost and consciousness, while ecotourism and regional holidays become more frequent due to extended holiday periods, reduced working time and improved rural environment.

Education and research/RTD

Education is aimed at self-fulfilment capabilities, employability and responsible citizenship. Significant investment in the public schooling system is made to guarantee high quality education for all inhabitants (gender equity), special support for migrants and others with risk of failure.

In academia, disciplinary education is combined with integrative training in the joint application of science, technology and humanities' methodologies to prepare students for transdisciplinary research and familiarise them with a basic broad and interdisciplinary academic knowledge base which will also be useful for basic research.

Public research focusses on problem solving for the public good, on technologies which are developed and adapted to such an end. The definition of problems to be addressed by problem solving research is based on a broad sustainability perspective, combining social, environmental and economic concerns. Problems to be addressed include social exclusion of the elderly, providing life long learning or solving environmental problems including the protection of sinks. In innovation the focus is on integrated socio-technical systems innovations, resource productivity increases incl. through ICT, dematerialised services and product service systems PSS. Corporate RTD expenditure including substitution research is expected to double as public research does not finance product development any more, as state RTD is focussing on pre-competitive research.

International relations: EU

The EU enlargement stops after Romania and Bulgaria are integrated, as Turkey withdraws its application and Georgia, Ukraine and the Balkan are part of the neighbourhood policy area. Neighbourhood policy with Russia, Maghreb and the Near East countries (from Saudi Arabia to Caucasus and Central Asia) is continued to create zones of stability in economic, social, and conflict terms. The establishment of common institutions and mutual institutional learning, technology transfer and cultural exchange safeguards long-term stability, including resource prices and exchange rates. Beyond the neighbourhood, the EU promotes détente-based strategic cooperation for a multi-polar world, including long term contractual system for secure resource supplies.

Continued support for ACP countries shifts from market based to development oriented measures, with extension of membership, primacy of development, and global sustainable development partnership initiatives of like minded countries supported by EU.

The EU internal market is deepened, based on the 'country of market' principle allowing for free trade while respecting the diversity of national social standards.

International relations: Global

In EU policies, the establishment of spheres of cooperation and shared interests replaces geopolitical approaches. Strategic cooperation, including a long term contractual system for secure resource supplies and fair trade agreements, including science and technology co-operation complements and partly replaces short-term market relations.

With EU support, the WTO is reformed, and the primacy of environmental and social standards included into its constitution - free trade is no end in itself. Stabilising commodity prices, and open markets in the affluent countries for processed goods from the South are trade priorities. Integrated assessments are mandatory for all trade agreements in which the EU participates.

Physical trade volumes decrease due to dematerialisation, higher transport cost and thus incentives increase to process materials in the countries of origin. This enhances value creation and income opportunities also in Latin America and even in Africa, with China and India taking the lead. Thus while trade in physical terms decreases, monetary trade volumes expand. The EU supports a capital depletion tax and improved international labour standards as a precondition for open markets.

Regarding the financial markets, the EU takes an initiative to reform Bretton Woods institutions, and plays a lead role in debt forgiveness for LDCs, pushes to harmonise currency policies to stabilise exchange rates, and in globalising the speculation reduction tax (Tobin tax).

As environmental justice is an issue in North-South relations as well as domestically, attempts are made to reduce the social and ecological debt. Calculation of environmental (and social) debt are used as an argument in debt negotiations, not monetary but morally. In this moral sense, increasing ODA (>0.7% GDP) is not a generosity but a partial compensation for past misconduct expressed as accumulated social and environmental liabilities (including climate change adaptation support). A symbolic excuse is made for the misdeeds of the colonial past and ever since. World poverty reduction programs beyond the MDGs and the WSSD action plan are politically and financially supported.

3.5 Outcomes

Climate change modelling assumptions and results

The climate is close to B1 due to the time lags between emission and climate effect, although SEDG does not represent a B1 world as described by the IPCC. Instead, the emissions will probably be significantly lower, as SEDG aims at climate stabilisation and includes an

elaborated policy of reducing GHG emissions based on the EU and IPCC targets: -10% by 2012, -20% by 2020; -80% by 2050). Similar considerations lead the Millennium Assessment to emission paths significantly different from the SRES scenarios. Nonetheless in the short to medium run the effects differ little from the BAMBU scenario results, with significant differences expected to emerge later, pronounced ones from the second half of the century.

A slow but significant sea level rise is expected along the lines of the IPCC projections; it is part of the already unavoidable trends but differs – in the long run – with the emission scenario and the model used. The EU is assumed to be rather well prepared for it.

The same holds partly true for river floods, storms, precipitation change etc –measures like strengthening inland dykes, extending retention areas and water storages, and adapting forest management to increasing top speeds of storms have been taken, others are under preparation.

South-eastern Europe, the Mediterranean and central European regions are most vulnerable to climate change, with impacts strongest on natural and human systems that are already under pressure. Northern and some western regions of Europe might reap some benefits from climate change, for some time.

The strongest increases in storm intensity and frequency affect, in this order: UK and Ireland (10 more severe storms over a 30 year period, top wind speeds increasing by 8-16%), Netherlands and Belgium (more frequent storms, and top wind speeds increase up to 15%), Northern France (5-10 more severe winter storms over 30 years, top wind speeds up 8-16%, number of stormy days up 25-50%), Germany (northwest) and Poland (north) up to 50% more days with extremely high wind speeds and 10-15% higher maximum wind speeds.

Land use impacts

Agriculture may enjoy longer growing seasons and increasing plant productivity, but in the Mediterranean agriculture suffers due to water scarcity.

Agriculture may enjoy longer growing seasons and increasing plant productivity, but in the Mediterranean agriculture suffers due to water scarcity. The technology induced linear agricultural plant yield increases slow down, from 1.5% p.a. until 2015 to 0.7% p.a. afterwards.

Fish stocks in European waters have been near collapse, but most are recovering.

Socio-economic implications

The standard path in the model cannot be modified to reflect working time policies for full employment. Alternatively, the expected additional employment per country has been externally set, and the economic results calculated. Labour force participation is possible to indicate, based on past data as starting point, and extrapolated.

The flexibilisation of labour is maintained, but with a strong self-determination component, due to extended industrial democracy (co-decision) and worker autonomy; Trade Unions are a relevant factor in companies and civil society. Higher education, work life balance and shorter working hours give improved opportunities to establish social networks, as communities provide infrastructure support.

Regarding the material basis, the tax based basic income (negative income tax NIT) provides a standard of living above the poverty threshold for all citizens. Consequently, the income distribution (Gini Index) improves, in particular as progressive taxes on capital and income narrow the gaps. Minimum wages are sufficient to make sure that precarisation is stopped and working poor do not exist any more. The correlation of income, life expectancy and occupational health problems is decreasing.

An increasing fluctuation of workers between employers emerges as with reduced unemployment workers can afford to look for better employment conditions, with limited risks in changing. Flexible work biographies are based on “mixed work”, combining employed, self-employed, unemployed and unpaid work simultaneously and over a working life, with improved opportunities to move from one to another due to mutual recognition of qualifications in caring, social and commercial work. This is also a contribution to gender equality as men are encouraged and nudged into participating in household and caring work. Job losses occur due to restructuring and lack of eco-efficiency, compensated by economic growth plus shorter working hours.

4. Shock scenarios, Wild Cards

As mentioned in the introduction, model based scenarios usually do not cover the existence of unexpected, or even unpredictable events, so called “irregularities”, “shocks” or “wild cards”. A shock in this sense is an unexpected event with impacts which are capable of changing the development trajectory, thus rendering all projections based on incremental change worthless. From this definition of a shock as a not anticipated event it is obvious that what is a shock to a society depends on the event as much as on the society itself, its reflectiveness and anticipation capabilities. Thus one key reason for shocks is not the sudden occurrence of unforeseeable events, but a deficit of the societal system to absorb relevant news, recognise their relevance and react accordingly and in due time (i.e. the sensitivity to early warning signals). Shocks are events which might happen, but we do not know if ever, and have no information about the probability of individual and the frequency of repeated events. However, what is unexpected or ignored is not decided by incident – the structure of society and its dominating paradigms determine what kind of information is looked for, found, and taken seriously.

For instance, given the current economic paradigm, absolute scarcities are not taken as a serious threat (although one can argue that historically this is what sustainability is all about: adaptation to – at least temporary – absolute scarcities). A collapse of supply is not foreseen in current thinking, at maximum price signals and subsequent efficiency gains and substitutions are expected. The same applies for the solutions suggested: although it is obvious that just a fraction of the global military spending would be enough to finance all kinds of global support and adaptation programs, suggestions to this end are dismissed as “unrealistic” as long as military definitions of safety are considered obvious and self-explaining.

Like any scenario, shock scenarios are based on a story line and as far as possible supported by simulation exercises. They as well have to be possible and plausible, before the shock and once the shock event takes place and alters the development trajectory. Usually for the period before the shock the existing scenarios are used (in ALARM we use GRAS and BAMBU), and the result of a shock is described as the deviation from the initial trajectory. Like the shocks themselves, which – as said above – do not imply any specific level probability (even a highly probable event can come as a shock if early warning signals have been ignored and an event which might have been expected in reality has not been so) shock scenarios do not need to be probable, it is enough that they are possible and plausible. The scenarios are then intended to illustrate the plausible effects of improbable events, or at least of events with unknown probability.

Any shock has repercussions beyond the economic system and the shock as well as the reaction to it changes the societal situation more or less gradually but always irreversibly (plasticity of the societal situation, disturbance beyond the system resilience). What happens and how it happens depends on societal processes, the state of the institutional system and the internal state of the society before the shock occurs. The selective brittleness of societies may lead to threshold effects (non-linearities), cases when a system collapse can result from a

gradual change in external factors, starting a new development and pattern formation process with a widely unpredictable final state or end point. According to systems theory, in particular mature systems with high productivity levels become increasingly vulnerable and prone to collapse, starting a new cycle of system development.

One specific difficulty of shock scenarios is that they do not emerge as an element of the standard model simulation, but must be triggered externally. This might disturb the coherence of the model runs, and simulating the extreme events assumed will in many cases even go beyond parameter changes the respective models can cope with, or refer to factors which cannot be parameterised at all. Although the latter is a common problem of all scenario developments, it becomes more pressing in the case of shock scenarios. Consequently, such scenarios must frequently work with semi-quantitative assessments and plausible reasoning instead of model simulations, which makes a comprehensive story line all the more important.

Finally, by varying relevant parameters and documenting the results, shock scenarios are de facto also sensitivity tests for the “normal” scenarios. They can be used to assess the stability of scenario projections, and to develop strategies which are expected to be effective over a range of different possible futures.

4.1 GRAS-CUT (GRowth Applied Strategy perturbed by a Climate shock: Cooling Under Thermohaline circulation collapse)



The shock

The GRAS scenario is expected to be associated with the highest emissions, which makes an event like the THC *more* probable under *this* scenario (although the probability still cannot be quantified). For this reason, the collapse of the global circulation and – most relevant for Europe, its Northern part, the Gulf Stream, is described and modelled as a deviation from GRAS. However, such an event could also happen under any of the other scenarios, albeit with a lower (but still not quantifiable) probability, and probably later. Similarly, the shocks described as deviations from BAMBU (below) can also happen under GRAS, but are taken here closer to the status quo by linking them to BAMBU.

Before the collapse of the thermohaline circulation, the socio-economic storyline is identical with GRAS. Deregulation, free trade, growth and globalisation are policy objectives, climate and environment receive minor attention, temperature increase is fastest among the three basic scenarios. Only after the shock, assumed to happen in 2050, alternative economic and environmental policies will be introduced to cope with its implications, mitigate the impacts

and adapt to the new trajectory as far as necessary. A change of the basic philosophy might be plausible, but is not assumed to happen.

Results

Climate change modelling assumptions and results

From a climate point of view, the changes will be severe, including winter cooling in particular in North-western Europe. Besides this trend in mean temperature, however, the occurrence of extreme events has to be taken into account. However, due to past global warming, the cooling effect is limited to setback of the climate conditions to the early industrial age.

Land use impacts

According to calculations of van Vuuren and Bouwman based on the SRES scenarios, the global ecological footprint for land use only (without CO₂ compensation areas) will rise by 20% until 2050, with China and India emerging as the main food importers. In that case, with greenhouse gas emissions rising by about 50% (we are in a GRAS scenario world), the aggregated footprint would rise from 12.6 Gha in 1995 to 20-31 Gha (after a historical increase from 10.3 to 12.6. Gha in 1975-1995). With Europe currently contributing 8% to global agricultural exports and possibly more in the decades to come due to future yield improvements, a reduction of European export capabilities might contribute to global food shortages. A reduction of the global footprint and thus an improved buffering capacity for yield failures would be possible (reduction of the global footprint to 15 Gha in 2050 after a peak of 19 Gha in 2025), but only under a scenario based on SRES B1-450, i.e. in a SEDG world.

Socio-economic implications

The assessment of the socio-economic impacts is not based on computer modelling, as the socio-economic model ends 2050, before the shock takes place. However, based on plausible reasoning and the experience with the dynamics of the economic system as modelled for the period before the shock, some rough estimates of impacts can be derived.

In particular, even a collapse which may be considered a sudden event from geo-science point of view will take at least one or two decades to materialise, and some of its impacts may take even longer. For the economy this does not represent a shock, as it is not sudden event on its own time scale. Rather, we have to deal with changing external conditions and the need for adaptation and structural change.

The main sectors negatively affected by the mean cooling caused by the THC will be those which depend on the outside climate, and which had been affected most by global warming in the decades before the shock: agriculture, forestry, tourism (less summer holidays in Europe, but more winter holidays again). Irregularities and changing precipitation patterns will affect water supply, and the reinsurance business, storms and frost will affect transport and cause investment in better provision against flooding from rivers and the sea (it is unclear, however, if these investments will need to be higher than those already taken to adapt to the warming of the decades before). The construction industry is likely to see a permanent demand, but only

partly from house insulation (a productive investment since it reduces energy consumption), but also from the reconstruction and strengthening of dykes, which can lead to a crowding-out effect against productive investment (however, as global warming continues, this effect is part of the development trajectory but not specific to the shock). On the other hand, appliances production is likely to profit (although on a minor scale, as heating installations today are not planned on the basis of a specific outside temperature), and water management will have less problems than before, but may be faced with new irregularities.

In total, the effect on the economy will be rather small, and it plausibly can be assumed that the crowding-out effect of public investment needs for precautionary measures impinging on productive investment will be overcompensated by the growth stimulus effect of such adaptation investments. For other sectors like clothing etc, even this effect will be marginal, as the average turnover rate of stocks is well below the speed of THC induced changes. In the service sector, few will loose and many will be unaffected; tourism for instance will have to adapt to THC change – which is probably more lasting but less severe than the annual fluctuations caused by TV news about civil unrest or local natural disasters; the latter may be more frequent under a GRAS-CUT scenario.

Indirect effects might arise in the health sector, although here positive and negative impacts regarding the frequency of different diseases make it unlikely to have a major effect to one side on a European scale. In North-western Europe, however, significant decreases in average temperature may change the patterns (making them more similar to today's and thus different from GRAS).

For energy consumption, a balance has to be calculated between additional heating in the North and energy savings made possible by cooling in other parts - the overall effect may turn out to be more marginal than one might have expected. Again, climate irregularities triggered by the cooling process may cause additional energy demand – its size, as compared to the total consumption – is impossible to estimate at this stage.

The only sectors inescapably affected are forestry and agriculture. For agriculture with its annual sowing seasons the adaptation by choosing temperature adequate species or varieties is no problem of principle (it is essentially reverting the process of the years before). Problems may occur in the most severely affected regions at the fringes of Europe, with land which had become arable in the North loosing this status again, while former arable land in the South cannot be reactivated since it may have undergone irreversible desertification processes. The resulting effects on the yield might be severe, as increasing yields are expected by the IPCC for the first 2-3°C temperature increase. This effect might vanish, but could be partly set off by the ongoing increase of CO₂ concentrations causing in quite some cases a fertilising effect.

The most serious problems might occur in the forestry sector, as trees are usually not harvested if younger than 80 years, and by 2050 many of the growing forest stands may consist of species the foresters considered to be best adapted to the expected increasing temperatures. When discussing these problems from an economic point of view, however, it must be born in mind that these three primary sectors combined represent less than 4% of the

GDP today, and after adjustment of the new member states to the European and global agricultural markets (we are in the GRAS scenario), most probably less than 2% of GDP and labour force by 2050. Even a complete collapse of these sectors would only be a minor problem for the European economies – as long as free trade guaranties sufficient supplies from other world regions. Even regional stresses on Finland and Poland would lead only to very localised crises comparatively easily absorbed by the national and European level.

However, although the THC would most strongly affect Europe, there might be international repercussions via the food and feed trade system.

4.2 BAMBU-SEL (Business As Might Be Usual perturbed by a Shock in Energy price Levels)

Deviations from BAMBU serve a double purpose. On the one hand they illustrate the policy effects of different measures to deal with climate change (different profiles of CO₂ emissions and land use patterns and their impacts in the medium to long term) and its impacts on the socio-economic system. On the other hand, such variations are a sensitivity analysis for the scenario developed.

The shock

For the BAMBU scenario, an energy price trends has been assumed based on the (rather low) assumptions of the 2004 International Energy Agency IEA cost scenarios, multiplied with a factor of 1.5 representing policy interventions, not a scarcity of supply. This is the economic shock the BAMBU-SEL scenario emulates: resource supply limitations, supply not matching demand (i.e. absolute scarcity). Such a shock places a twofold restriction on economic development, on the one hand by increasing prices and on the other by lack of resources.

Unfortunately, so far none of the existing Input-Output models can handle both aspects, and economic theory concepts based on equilibrium thinking are helpless when absolute scarcities prevail. Models and theory alike are capable of dealing with relative scarcities and the resulting price increases, but do assume that with a higher price the demand is matched by additional supply. First attempts to simulate absolute scarcities (a capping of physical resource supply) has shown that sectors may be affected differently than by the price effect, underlining that simulation runs with existing models, including impacts on economic growth, trade and consumption are instructive, but cover only one part of the shock impacts. A second source of uncertainty regarding the simulation results is that price increases by a factor four may on the one hand be well below what could be expected in the case of peak oil, but are already close to the capabilities of the model. It is not always clear if critical outcomes are the result of model failures, or a correct indication of market economy failures to be expected. Even more than in other cases, the modelling results have to be taken with healthy scepticism when interpreting them against the background of the scenario narrative.

The scarcity causing the shock could be a physical one (production declines), a political one (production is reduced below capacities), or an economic one, which could be caused by demand growing faster than supply (e.g. high growth in India and China), or new supply

turning out to be extremely expensive to generate. The impacts will affect all kinds of business based on the “embodied energy” in the sector’s supplies and products.

Amongst energy experts, it is disputed whether or not future supply will be able to grow in line with increasing demand. So while the three scenarios reflect the assumption that over time increasing investment in exploration and processing of oil and gas will be able to overcompensate the consumption growth, BAMBU-SEL refers to the alternative view, that “peak oil” is reached rather soon and a relative shortage of supply will result in a stable, high price level for gas and oil, affecting the market price of all other energy carriers as well.

Climate change modelling assumptions and results

From a climate point of view, the BAMBU-SEL scenario is identical to BAMBU until the shock is assumed to happen. After that, it depends on the narrative major changes for the climate trajectory result. For instance, if diminishing oil and gas resources are replaced by coal and lignite, the emissions might increase, whereas their replacement by energy saving and renewables would lead to a significant, climate relevant decrease of greenhouse gas emissions.

Socio-economic implications

In its substance, an energy price shock is not exogenous to the developments described in the three story lines and illustrated by the scenarios, but rather to be expected as a consequence of the market trends described in the narratives: the development leading to price shocks is path dependent, and the pathways are described in the story lines. For instance, given recent developments it can be considered plausible that as no longer only 20% of the global population are competing for its resources, but with the rise of the BRICS countries (Brasil, Russia, India, China, South Africa) additional 50%, competition will get stronger and thus prices of resources will continue to rise rather than drop, at least as a medium term trend (let alone the risk of a political crisis in few supply nations or regions). Furthermore, as these countries (BRICS) are the location of some 60% of the World’s resources, there is no genuine reason to assume that the industrialised countries will have privileged access to these resources. Consequently, as the rise of new consumer countries coincides with the expected date of “peak oil” during the next decade (and “peak gas” about a decade later), not only high prices and high price volatility is to be expected, but even absolute scarcities may occur. For the project, it is appropriate to consider the oil price shock as an endogenous result of the trends described in the narrative, while in the scenario modelling it is introduced as an external shock. This is due to the fact that the date of when such a shock may happen and its size and dynamics are not predictable, due to the high levels of uncertainty involved. Thus for the scenario building, externally chosen figures have to be used.

Whereas the current situation has been characterised as one of mutually taking hostage without the affluent nations realising that they are also under threat, with a shock situation this pattern may change: the role of the suppliers gets stronger in a market characterised by permanent unsatisfied demands, with political repercussions. Resource owners gain a stronger position, which resource consumers must accept (while looking for alternatives to reduce demand), or react by non-market measures, e.g. by military means. For Europe, for instance,

this trend will shape much of the neighbourhood policies and conflicts, with Scandinavia and Germany heavily dependent on Russian gas, and the Baltic countries for historical reasons afraid of Russian pressure and sceptical against close collaboration. Similar problems may occur between the Mediterranean countries north and south of the Sea: The EU is dependent on Mahgreb resources, and Mahgreb countries want access to the EU labour markets. The potential outcome of this foreseeable conflict has not been sufficiently discussed so far, there seems to be no long term plan available how to find constructive solutions to these challenges. Policy options to deal with such a shock are not trends, but results of deliberate choices and must be treated differently: their impacts are something decision makers have to justify with the decision they take. For instance, if a certain share of fossil fuels is reserved for the chemical industry (as demanded by the lobby), this privilege has to be justified to energy consumers. Similarly, alternatives must be well-thought. For instance, there is a high probability that biofuels (methanol from agriculture and forestry) will be offered as an alternative in times of oil scarcity, as already today, on a smaller scale, they are part of the EU policies to reduce oil dependency. However, declaring them to be the answer to the problem, and thus having a technical solution at hand with no need for behavioural change, would be misleading. First of all, already now the total agricultural area of the EU would not be sufficient to meet its gasoline demands -there is no alternative to saving and reducing demand (with implications for transport, housing, lifestyles, etc.). Secondly, this situation might get worse if with climate change induced water scarcity the average yields do not rise as expected. Thirdly, nature protection areas needed in times of climate change to permit the 'migration' of ecosystems as an adaptive measure need area. Finally, planting homogenous cultures of energy plants wherever possible, i.e. not only in highly productive areas now under use for intensive agriculture, but also on extensively used and marginal land, or even opening nature protection areas for energy plantations would significantly reduce the diversity of the landscape and in itself represent a major threat to biodiversity (in increasing order of substitution for extensive, marginal and protected land). Using highly productive land could either cause a shift of agriculture to less favourable regions, or lead to increased imports; in BAMBU-SEL, the first option is assumed (under GRAS, the second option would be considered more plausible), with serious repercussions on the long term development of the agricultural incomes and biodiversity of regions less favourable to agriculture.

A second impact on agriculture may result from increasing input prices for fertiliser, pesticides and the energy needed for mechanical equipment (electricity, fuel). If such an increase in supply prices cannot be compensated through increasing product prices, a significant economic pressure on agriculture may emerge, adding to the imports from countries with less capital and resource intensive agricultural production system (mainly in the Third World). It is a policy decision within the Common Agricultural Policy if quota and prices are adapted to make revenue match the increasing expenditures, or if due to lack of finances and in order to reduce the size of a costly sector, the opportunity will be seized to increase the pressure on agriculture. While the latter option fits well into a liberal GRAS scenario, under BAMBU we assume that cost compensation will be the EU strategy chosen, minimising the oil price impact on structural change in the agricultural sector. The kind of

food and feed imported will be more dependent than before on the possibility to sea transport, as this is the least costly means of bulk transport, particularly important in times of increasing energy prices.

Another sector which could be seriously affected is forestry – intensive use of high yielding trees provides an energetically efficient alternative to energy crops, in particular due to the lower input demands of trees. If biotechnological research (one focus of research funding in BAMBU) succeeds in biodegradation of Lignin, which is so far useless for biofuel production, but is used for electricity generation by incineration, the material usable for liquid energy carrier production from tree plantations would suddenly double. Under shock conditions intensified public research in this area is expected, plus economic incentives, making them economically even more interesting, and a fading away of the public disapproval of GMOs. Such a development would not only tend to lead to new claims for industrial energy forestry, but it is likely that new – and less biodiversity-friendly – management methods would be introduced into forestry on a much broader scale. Although there are only about 2% of virgin forest area left in Europe, the trend towards a more sustainable forestry of the last decade has been important and could be completely reversed.

Other alternative sources of energy may involve other problems which need to be taken into account before a decision is taken. This refers to their economic, environmental and social impacts, as much as to the acceptability to the public. Nuclear energy, while being a low carbon primary energy, carries with it risks considered unacceptable by much of the European population (different by country), and has serious economic problems. Nuclear based coal hydration to produce gas and oil substitutes faces these problems and causes significant upstream CO₂ emissions, comparable to a gas power plant. However, even if the concerns regarding energy supply would turn the public mood in favour of nuclear energy, the long construction times will make it unfeasible as a short term remedy to higher energy prices or absolute scarcity – for this reason, no increase of nuclear in the immediate aftermath of an oil price shock is assumed (trends may change in the longer term). Wind turbines meet public resistance in some places, as does hydro energy in sensitive areas; in particular a massive extension of small hydropower plants runs the risk of massively impacting on aquatic biodiversity.

Energy quality aspects have to be taken into account (availability, efficiency, emissions, flexibility etc.). There might also be impacts on the urban development and settlement patterns towards more dense urban structures such as those as assumed for the SEDG scenario, but more pronounced in the long run if the energy prices remain on the shock level or increase even further.

In total, significant changes of demand structures (i.e. energy saving) seems an inescapable necessity, going beyond the short-term available technological improvements and enforcing a changing consumer behaviour (which is assumed not to have changed dramatically; it is rather much the same than today under the BAMBU scenario). If a market based solution is sought, i.e. adaptation via rising energy prices, the enforced changes in lifestyle and consumption patterns will be distributed throughout the population based on their purchasing power, with

the poorer segments already spending a higher share on energy. Thus distributional conflicts based on energy poverty might arise, much more so than a serious threat to business as a whole.

On the macro level, the economy would experience an inflationary push, but according to what Rothschild {Rothschild, 2005 #3490} has shown - and contrary to public belief – empirically higher inflation is as often correlated with higher growth than with lower growth rates. Consequently, while a difficult adaptation with negative impacts on GDP is to be expected, already in the medium term no crisis of the economic system is to be expected (of course, there are thresholds for what the economy can buffer, but where they are is not yet known – according to modelling results, even a quadrupling of energy prices would not be a lethal shock). The financial system would be one of those in charge of buffering the shock of rather suddenly (i.e. to most market participants unexpected) changes, while the energy sector would lose turnover, but might enjoy windfall profits.

Biodiversity

Positive as well as negative trends for biodiversity will emerge, based on policy assumptions e.g. regarding biofuel support. It remains to be seen which kind of impacts dominates in the long run.

4.3 *BAMBU-CANE* (Business As Might Be Usual perturbed by a ContAgious Natural Epidemic)

While GRAS-CUT presents an environmental and BAMBU-SEL an economic shock, BAMBU-CANE is based on a social shock. The purpose of this choice is to illustrate the cross cutting effects shocks in any of the dimensions will have, without claiming that the “wild cards” chosen are more relevant or probable than other possible shocks.

The shock

The scenario assumes a global pandemic to happen, with social and political implications and reactions worldwide, as well as in Europe. Such a pandemic will change population structures and demographic development (also dependent on the existence of specially susceptible age groups), undermine livelihood and communities. Based on the experiences from the “Spanish Flue” in the beginning of the 20th century when 20-40 million people died, a justified guess for the lingering death rate might be 0.6% of the global population in the case of an Avian influenza. In total, there might be about 100 m deaths (more than in both world wars), and a much higher number of temporarily ill people.

Given the global spread, the size and the complexity of the resulting impacts, no model is capable of assessing the outcomes of such a catastrophe. So while taken previous modelling experience into account, the assessment of impacts in this case is based on plausible reasoning. Consequently, the assumptions are up to debate, and the results are mainly qualitative.

In this situation, no aspect of everyday life will go unaffected; there will be impacts on the economic, environmental and social dimension. The size of these impacts in any specific country will be highly dependent on three factors:

- the preparedness of the countries in terms of stocks of pharmaceuticals, hospital beds, educated health care staff, etc. – all of this resource dependent. Another aspect is the mental preparedness of the population in dealing with shocks,
- the time available for preparation, i.e. the period between the detection of the pandemic and its occurrence in the respective country. This in turn depends on the velocity of spread which is influenced by the virus itself (are there early symptoms or will the infection have been spread widely by any infected individual before it is identified?)
- the vector systems (international trade and travel, controls and restrictions) which influences the speed with which the virus is travelling.

The disease itself and response strategies have significant distributional, equity and other social implications: Who is treated first or last, is there a public health system (or at least public control over a private one), or will people be treated based on their ability to pay? The latter might accelerate the spread of the disease.

Results

Climate change modelling assumptions and results

Up to the catastrophe, the BAMBU-CANE scenario is identical to BAMBU, and so is the climate trajectory. Then, based on the BAMBU-SEL assumptions, a large scale collapse of the economy leads to a significant decrease of emissions due to reduced economic activities at least during the crisis and in most of the affected countries. Dependent on the severity of the shock, the use of resources and the environmental impacts (such as CO₂ emissions) are reduced significantly and future economic recovery might start from a global GDP reduced by a fifth, a quarter or even a third or more, and the pace of recovery might be faster or slower than past economic growth. As the recovery is assumed to start with a limited growth rate from a lower level, the resulting atmospheric greenhouse gas concentration will be lower than under the initial scenario. Climate change could be mitigated by these effects, with a significant delay, and possibly (if a rapid growth period follows) only for a limited period of time and/or to a limited degree. In any case, a significant and reduction of emissions lasting for some decades must be expected (as compared to BAMBU), although it cannot be quantified. The level of impact on climate change cannot be quantified, as the economic impact and thus the change in emissions is not quantified either.

Socio-economic implications and speculations

Regarding the economic effects, a pandemic leads to impacts on present and future economic activities and shift the spectrum of public and private expenditures. For instance

- The demand for medical services and pharmaceuticals will most probably be skyrocketing

- A reduced demand will occur in many sectors, in particular in service sectors (tourism, public transport, leisure, sports, restaurants etc.);
- A reduced production in industrial sectors and in agriculture are plausible due to missing staff, eventually – in the case of extended absence – leading to undersupply with essential goods. In this case, for instance a food shortage is plausible.

We can differentiate between two forms of emerging costs, (1) the direct costs of increased illness and death, costs of hospitalization and medical treatment, (2) the indirect costs of public and private preventive, control and coping strategies (they might be very high, depending on the severity of the pandemic) as well as a decline in the active labour force and thus reduced production capacity. This reduction is not only based on temporarily ill persons, but also on exposure avoidance reactions of still healthy people, who do not dare going to work, stop direct communication, cancel meetings and stop travelling. This might also be true for the functioning of the education system (children not going to schools etc.).

It is furthermore plausible to assume that in order to gain time in the event of an emerging pandemic, states would do whatever they could to keep the disease outside their borders, or at least delay its arrival. The measures at hand, which would most probably be made use of, include restrictions to international trade and travel, enforced either by governments or by individual action of citizens and consumers (which in turn might stimulate government activities). Even long before national economies, international trade may fall victim to individual and collective precautionary measures.

However, as we do neither know the illness rate nor the number of people not going to work out of fear (the latter may be the highest and economically most significant figure, according to recent experiences in China and South Asia), it is impossible to quantify the resulting effects. Their size is dependent on many factors, such as urban-rural population ratio, national and international mobility (exposure probability), status of the health care system (preventive and curative), level of education, influence of mass media (prevalence of self-designed exposure avoidance strategies), national cultures (will health workers, nurses, ambulances, doctors stay on duty or also try to escape?), etc.

Obviously, it is impossible to calculate the resulting temporary reduction of the available labour force, neither qualitatively (i.e. which sectors are affected? – probably all), nor quantitatively (i.e. the aggregate production loss and GDP decline). Although the lack of data makes model calculations impossible, first model-based estimates showed very roughly that

- if one in 20 members of the labour force would not be available for a significant amount of time (some weeks at least), a difficult but manageable situation for the economy would result (assuming that all sectors are effected equally);
- if one in 10 members of the labour force were absent for some extended time, the economy would be in a critical state, and
- if one in five members of the labour force were missing, an economic collapse would be unavoidable.

For the shock scenario we assume that the latter case is realised: people migrate to presumably “safe heavens”, party abroad but mainly in the countryside, where they are exposed to less people and furthermore can minimise their infection risk by avoiding contacts.

Dependent on the level of impact during a pandemic, the subsequent recovery phase could have significantly different characteristics. In the worst of cases, not only would the level of economic activity be severely reduced, but relaunching a modern, complex and interconnected economy after a collapse is something which has never been done and which might take years if not decades. This, however, implies that a temporary absence from production process, if extended due to a real or perceived risk of infection, would result not only in a collapse of the economy, but also the collapse of supply (stocks will low quite soon) and the impossibility to simply return to the former working and living places. The need for shelter and basic supply would lead to the establishment of a basic but growing infrastructure, satisfying human needs and not easily given up once established, So while after a certain time some people may migrate back to the cities, others will realise that their food supply is best secured in the country side, leading to an extension of the agricultural area, but probably with a significantly reduced use of agrochemicals (they are not available). Such a development would have significant impacts on population distribution and land use patterns, and consequently on biodiversity.

Furthermore, after a pandemic, the infrastructure might be inadequate (oversized) for the remaining population, thus significant investments would be required from a weakened economy and society in order to keep the cities hospitable – an effort which may take time and support the tendency of staying in the country side.

Reconstructing the infrastructure and adapting it to the changed demand (preferences, settlement patterns) may constitute a significant growth potential, but starting from a reduced level and not necessarily contributing to consumption possibilities (due to the necessity of adaptation, absorbing capital investment).

Finally, the re-establishment of international trade might be hampered by both, economic difficulties (bankruptcy of main exporters, importers and transporters, changing production and consumption patterns), and the psychological effects causing scepticism against too close international integration (as far as this is recognised as one of the reasons contributing to the heavy toll the pandemic has taken in the respective country).

Box

Preparing for a avian flue pandemic

One of the events with a high probability of occurrence is the outbreak of new, highly infectious diseases, such as the avian influenza. This viral pandemic can currently only be transmitted from animal to humans, but not from humans to humans. However, experts assume a high probability of a mutation of the virus towards a human to human transmission possibility.

Although the time and place of such a pandemic is highly uncertain, it is necessary to be prepared for such a case: the negative consequences can be mitigated by transparent

information of the public and adequate crisis management. Therefore the WHO and other international institutions have taken precautionary measures by establishing observatories and by developing preparedness plans. With its global influenza preparedness plan the WHO assist its Member States and those responsible for public health, medical and emergency preparedness to respond to threats and occurrences of pandemic influenza.

According to the WHO there are six phases of pandemic alert; we are currently in phase three which consists of "Human infection(s) with a new subtype, but no human-to-human spread, or at most rare instances of spread. Ensure rapid characterization of the new virus subtype and early detection, notification to a close contact". Phase one and two are called interpandemic period, phase three to five are called pandemic alert period and phase six is the pandemic period.

Based on the definitions of the WHO, the EU developed a pandemic plan, which outlines the role of the Commission and the Member States in pandemic preparedness planning and defines key actions at pre-determined phases and levels in the main areas of management and co-ordination, surveillance, prevention, mitigation and response, communication, civil protection and research.

The national preparedness plans are also based on the WHO as well as on the EU guidelines.

5. Conclusions: policy recommendations

One of the elements constituting the innovative methodology of the project is the central role of qualitative narratives, aspects of which are illustrated using different models. The modelling results, however, are only to be understood if interpreted in the context of the narrative, as this adds the aspects the respective model cannot cover, and provides the link to the other models applied. To do so in a systematic fashion, an iterative process of model parameter harmonisation is necessary, again based on the narratives. The challenge of such a kind of work is bringing together different world views, time horizons and levels of uncertainty and unpredictability inherent to the different fields of investigation.

As linear change is inherent to all these models, the “wild card” events to be modelled or at least illustrated by shock scenarios are an indispensable tool to assess the diversity of possible futures. Sustainable strategies are then those which remain effective under a wide array of possible futures.

5.1 Policy conclusions

Deriving policy recommendations from the discourses, story lines and modelling exercises is one of the objectives of the project. In doing so, we are aware that it is not the task of the scientist to try to predetermine political decisions, but to provide the best available information, and – in her role as a citizen – protest if such information is neglected in the decision making process. However, if scientific information is to be used in the political process and in governance, it must be made available in a suitable manner: accessible and understandable, and taking into account the institutions (organisations, mechanisms and orientations) of societal decision making, their constraints and framing conditions. For instance, the sensitivity of organisations to specific information, and to specific forms of presenting information must be respected. Regarding mechanisms, it must be clear which kind of regulations and incentives can justifiably be considered effective, economic incentives via prices, interest rates etc, public planning, legal regulations and standards, or what else? On the other hand, the question must be answered what are the major obstacles to what is considered an adequate policy in a sustainable development perspective. Looking for obstacles can be a challenging empirical work in its own right, often leading to surprising results like the recognition of the dominant role of the level of corruption for the implementation of EU environmental directives, much stronger than income levels or other socio-economic factors.

Decisions are not taken without actors, so the actors must be visible in the scenarios and clearly addressed in the policy conclusions (they play a key role in the deliberation matrix). The key question to each actor is about her possible and necessary contribution to a switch from one development path to another, in order to achieve or avoid certain developments which are considered plausible under different development paths.

5.2 Outlook: the deliberation phase

For policy conclusions to be effective, two minimum conditions are: they must be known to decision makers, and they must be considered relevant by them. In order to achieve this, the project has a deliberation phase, where stakeholders from different parts of society, as well as EU officials are invited to discuss the results and shape them to meet the needs of European decision making (including some, but not too much cherry picking).

Only in the dialogue with decision makers, suitable ideas, plans and strategies for switching from one story line to another can be developed.

Summary of the variables and models used in ALARM

Variables simulated	Spatial resolution	Time resolution/ horizon	Scenarios simulated
1 Socio-economic variables Variety including GDP, unemployment, trade balance, sectoral production, budget, ... Change in demand for agricultural goods, changes in biomass use, global trade development by country and product group	National, country groups, global trade flows	Annual up to 2020, extrapolation to 2050	GINFORS: GRAS, BAMBU, SEDG, Semi-quantitative discussions: GRAS-CUT, BAMU-SEL, BAMBU-CANE
2 Climate variables Mean temperature (°C), Precipitation (mm), vapour pressure (hPa); cloud cover (%) diurnal temperature range (°C) Mean atmospheric CO ₂ concentrations (other observed data are available from some sites – see text)	10' or 0.5° grid	Monthly data (daily for RCM) Observed data: 1900-2000 Scenarios: 2000-2100	HadCM3: GRAS, GRAS-CUT, BAMBU, SEDG + BAMBU/PCM, BAMBU/CSIRO2, BAMBU/RCM
3 N deposition rates oxidised nitrogen species [g m ⁻² y ⁻¹] reduced nitrogen species [g m ⁻² y ⁻¹]	10' grid (reported) Effective resolution 0.5x1°	5 year steps 1970 until 2100	GRAS BAMBU SEDG
Land use variables % of urban land use, % of crop land, % of grassland, % of forests, % of designated areas, % of biofuels, % of surplus land.	10' grid	Baseline (2000) Each year until 2080	MOLLUSC: GRAS BAMBU SEDG Semi-quantitative discussions: GRAS-CUT, BAMU-SEL, BAMBU-CANE