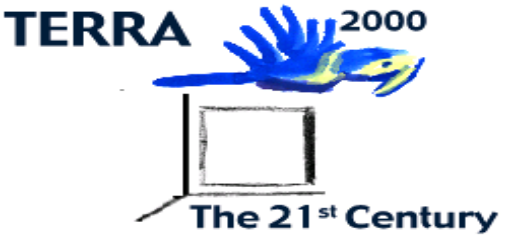


# TERRA 2000

***IST-2000-26332***

# Towards A Sustainable Information Society

**Tools for supporting policy making at the IS-SD interface so as to maximise the Information Society's benefit to humankind**

**Workpackage 15**

**D15.2**

**Final Draft**

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# The Story of TERRA

**Tools for supporting policy at the IS-SD interface so as to maximise the Information Society's benefit to humankind.**

# Foreword

The TERRA project is concerned with the creation of scenarios and models of present and future developments in order to support policy debate and decision aimed ultimately at optimising the contribution of Information Society Technologies to Sustainable Development. Such a wide and complex subject area merits rigorous and systematic development. For the purposes of TERRA it is taken as read that attaining Sustainable Development (as defined by e.g. the Brundtland Commission) is both desirable and something to which the Information Society and its associated technologies can contribute. The IS is inevitable, and attaining sustainability necessitates an understanding of the implications of the IS and the tools and tendencies it contains.

The starting point for the whole TERRA topic is thus the 'IST proposition:'

*The new technologies of the Information Society (ISTs) seem likely to offer scope to enable economic growth, and to allow a more equitable distribution of wealth, without necessarily increasing consumption, pollution and energy use.*

This is a proposition in need of both proof – in that many would deny it – and implementation – in that sustainable development within the inevitable IS requires active and adaptive employment of ISTs. To meet these requirements, TERRA decomposes the IST proposition itself into sub-propositions relating to specific domains – these form the first section of the Story of TERRA. Implementation of these propositions is a task for public policy as well as private action; the second section of the 'Story' therefore develops the progression from historic data (affording hindsight) through models and scenarios (whose main purpose is shedding light on the inner workings of the IS-SD interface, i.e. providing insight) to their contribution to the necessary background for the creation of public policy (which necessitates some complementary foresight). ISTs are not, historically, the first technological leap[1] to produce sudden and marked impacts on society – considerable pre-existing knowledge is available to guide us in conceptualising and articulating the manner in which technologies influence society: the third section of the Story of TERRA surveys the resulting conceptual framework, divided into chronologically and effectively distinct phases with typical

[1] The IS also involves indirect effects associated with technologies from the proximate (networking) to the systemic (globalisation). The globalisation of the 1870's-1910's, driven by general -purpose transport and communication technologies - and thus by wider distribution of human brain power - did not produce the same effects (esp. 'hollowing out' of the middle of the income distribution). History teaches us some things but its deepest lesson is that it does not teach us everything.

accompanying 'rebound' effects. At this stage the potential for individual action[2] through lifestyle change is introduced into the argument.

Such conceptual frameworks help interpretation of specific data; but these data must exist, be gathered and collated, and ultimately be handled by suitable analysis tools. The fourth section describes these 'windows on the world:' data sources (UN; OECD; World Values Survey etc), the particular TERRA analytical tools (ASA, IFS) and the scenario framework.

The next two sections utilise the principles and data sources defined in previous sections to illustrate the work of the project in developing, respectively, specific policy perspectives relating to human and social development (Section 5) and to environmental and ecological considerations (Section 6), showing the use of scenarios and models to illuminate particular problems. The seventh and final section considers a number of topics highlighted by TERRA relating to an even more uncertain future in which change is discontinuous or radical, or where more work is needed – for instance where data or indicators are missing; where theory is inadequately developed; and/or where policy issues have received insufficient attention.

Appendices discuss key concepts (Concept Sheets) and particular mechanisms (Insight Primers) and map the very large quantity of papers and reports produced in the TERRA project. The accompanying CDs contain the whole TERRA resource of data and discussion, as well as the tools required to utilise both empirical data and theoretical knowledge in pursuit of further understanding of the issues surrounding the contribution of ISTs to sustainable development.

The Story of TERRA thus goes well beyond a simple and finite explanation of a limited number of specific problems. Rather, it is a work space containing: a set of tools with an instruction manual; a vast mass of historical data with an interface and tools for exploring past and future; and a sufficient examination of underlying theories to facilitate their use in addressing the real problems facing the world. The examples offered are just that – examples or instantiations of the tools and techniques. The real Story of TERRA is created by you, the user responding to specific issues in the real world. Although intimately concerned with the future, it is not a crystal ball: it should illuminate a likely range of futures but not a single choice: for this reason its final outcomes are described as 'policy briefings'. Uncertainty will always

[2] Individual action complements policy and business as a sphere of action and as a way of linking sustainability and IS evolution. No domains is sovereign; each must look to the others with hindsight, insight and foresight, and each must take some pro-active responsibility for addressing sustainability. Ultimately, we want policy makers, business leaders and people (as individuals as well as parts of 'civil society') to reflect on this analysis and employ these tools.

remain in the making of policy, but TERRA's tools should enable at least a realistic assessment of the extent of that uncertainty.

This document has been distilled from the very large quantity of work in TERRA by its editors, who have added introductory, explanatory and linking text to what is essentially a guided tour of the work. Those who find items of specific interest are then directed to the footnotes, reference and catalogue Raisonnée for more detailed discussion,

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# Contents

# Section 1

## The IST Proposition and its Sectoral Sub-Propositions

# 1 The IST proposition and its sectoral sub-propositions

## 1.1 Introduction

TERRA utilises scenarios and models to achieve insight into the implications (for better or worse) of the technological and scientific developments of the Information Society (more concretely, the Global Networked Knowledge Society – hereafter, GNKS) for environmental, socio-cultural and economic sustainability. The concepts of sustainability and its 'pillars' lead to a set of propositions requiring demonstration: an overall 'ISP proposition' and constituent sub-propositions relating to the individual 'pillars' of sustainability together with an additional 'distributional' proposition that recognises the vital distinction among states that may be satisfactory in aggregate (e.g. a high per capita GDP) as to whether or nor localised failure (relative poverty within affluent counties, for instance) renders them ultimately unsustainable. These propositions are as follows:

**The IST Proposition**

*The new technologies of the Information Society (ISTs) seem likely to offer scope to enable economic growth, and to allow a more equitable distribution of wealth, without necessarily increasing consumption, pollution and energy use.*

TERRA not only tests this fundamental 'IST proposition' and its sectoral sub-propositions it also offers guidance on how the vision they embody may be made a reality.

## 1.2 Human Capital in the Information Age

"*Knowledge and information are now being produced like cars and trucks were in earlier years*[3]*".* But just as the importance of land in production changed dramatically as the economy moved from agriculture to industry, so too does the movement to a knowledge economy necessitate a rethinking of economic fundamentals. In the Information Age trades intellectual rights rather than physical products. It costs far more to develop new products than to produce them. Skilled, talented, innovative and fulfilled people constitute human capital, which fuels economic growth. All people everywhere have the potential to contribute. One major policy dilemma already facing decision makers is how to secure the supply of human capital with the declining and aging population.

**Economic sustainability propositions**

- ISTs can catalyse human capital expansion and thus promote sustainable economic growth
- Expansion of the GNKS can sustain and diffuse increases in productivity

[3] Stiglitz (2002).

and market efficiency throughout the globalised economic system.

## 1.3 Equity and Growth

"Social capital is the glue that holds a society together[4]." Inequality undermines social capital, fuelling illegal acts, crimes, terrorism, etc. ISTs put a premium on highly educated labour as a source of economic growth, while globalisation supported by information technology reinforces the "winner takes all" tendencies of an increasingly information-rich economy. A major dilemma for the 21st century will be how to balance the economic growth needed to reduce unemployment with the reduction of inequality needed to secure social capital.

**Social sustainability propositions**

- While initial deployments of ISTs and 'New Economy' dynamics have tended to exacerbate welfare, digital and/or income 'divides,' the unfolding of a GNKS based on open and universal access can harness the same technological, market and social forces to promote greater equality of opportunity compared either to recent experience or the pre-GNKS era.
- The GNKS encourages and influences the processes of globalisation and can foster collective awareness of collective problems, mobilise local responses and promote emergence of new governance institutions to balance local and global problems, incentives and powers to act.
- While the mere fact of globalisation – the connection of each to all – does not of itself imply either integration or convergence, ISTs can facilitate mutual awareness and respect.
- The GNKS can encourage peace and minimise conflict by substituting a complex interlocking maze of global allegiances for previously narrow tribal and racial allegiances.

## 1.4 Information Age Sustainability

ISTs profoundly affect environmental, economic, societal and cultural sustainability. In particular, their environmental impacts may help or hurt 'sources' (life support systems and resources) and 'sinks' (human domination of nature from biodiversity to climate change). On one hand, ISTs bring a burgeoning middle class, increasing consumption loads; on the other, they allow more efficient extraction, accelerating exhaustion and delaying development of substitutes. Rebounds and secondary and tertiary effects are already well understood in some circumstances – but by no means all. Policy issues include informational approaches to enhancing efficiency of resource use, corrective taxation, support for development of alternatives, etc.

[4] Puttnam (2000).

**Environmental sustainability propositions**

- Emergent technologies based on information (from ICTs to bioengineering) can dematerialise production and distribution of goods and services by reducing associated material inputs and waste outputs.
- The new technologies and the new forms of human interaction they support can lead to substitution of immaterial goods and services for material production and consumption.
- Dematerialisation and immaterialisation reduce the opportunity cost (price) of material inputs and environmental sinks and increase the welfare content of income and wealth. The relative price changes can induce substitution of material for immaterial inputs. Increased purchasing power can stimulate consumption of both material and immaterial goods and services. These substitution and income effects can outweigh the benefits of the original changes.

## 1.5 Distributional Impact

Analysis in all three areas described above has largely been concerned with aggregates and averages, even when the phenomena being explained involve *comparisons* of growth rates, standards of living, rates of environmental decay, etc. Recent theoretical and empirical work strongly suggests that the important relations can best be understood by considering entire distributions or populations. For instance, the distribution of access to inputs (including human capital) can provide a better explanation of growth and convergence than total or average input levels; the welfare implications of inequality are strongly affected by the reference groups considered by people around the world – and thus by those portions of the global distribution in the IS spotlight; and environmental sustainability and resilience depend on the spatial and temporal dispersion of economic resource exploitation and discharges. Conversely, the impacts of economic, societal and ecological development on these important distributions can only be understood if the mechanisms of dispersion and differentiation are included in the analysis.

**The distributional proposition**

- Distributions (e.g. inequalities) matter at least as much as aggregates because: i) welfare and incentives are relative; ii) globalisation and the network economy hold out the promise of greater equity[5] while increasing the likelihood that *laissez-faire* policy will exacerbate divides; iii) different parts of distributions have potentially divergent values and sustainability footprints and responses to policy and economic/political, etc. forces; and

[5] e.g. by reducing the digital divide, then the knowledge divide, then the income divide, then the welfare divide.

iv) network evolution can lead to small worlds, stable diversity, global convergence, etc. with only minor changes in the underlying parameters[6].

[6] Hence the salience of weak signals and the need to consider robustness and resilience.

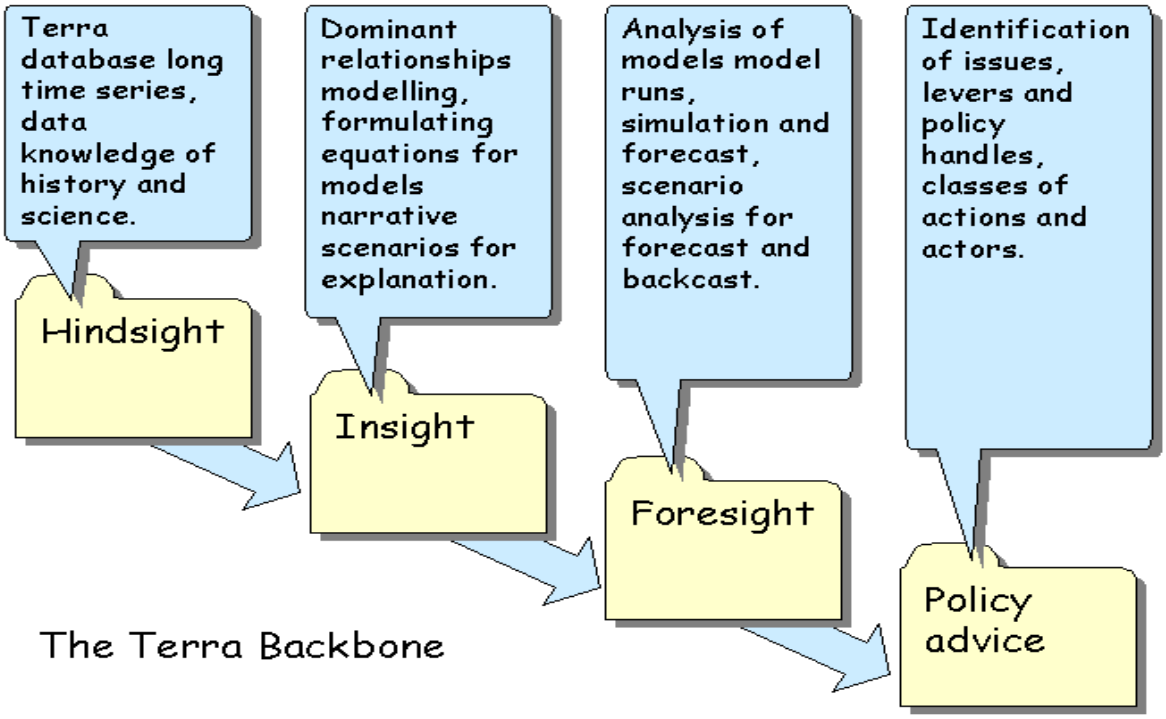
# Section 2

## Support for Policy Making to Implement the I.S.T. Propositions

# 2 Support for Policy Making – TERRA 'Backbone'

Underlying the TERRA work of expanding and testing the 'IST Proposition' and optimising ISTs' contribution to sustainability is a progressive development of understanding from the insight to policy creation.

TERRA is much concerned with modelling and with the use of scenarios, but is not tied to any single paradigm of modelling or of scenario formulation. The TERRA backbone runs from established data and knowledge, through the creation of insight via suitable established formal model/scenario techniques to the enabling of foresight. Policy advice derives from foresight mediated by insight. Insight thus lies at the heart of TERRA. The models in TERRA are made in a transparent way – they are not intended to be 'black boxes' whose workings may only be understood by the initiated, producing definitive forecasts and prescriptions, but consist rather of visible structures of explained linkages whose workings can be examined and discussed as a means of coming to greater understanding. It is through the visibility and quality of the reasoning that policy advice in TERRA is given substance and made trustworthy: ultimately, the purpose of TERRA is that its advice should be accepted and acted on.



The relationship between the Information Society Technologies (ISTs) themselves, and their wider societal impact in the shape of the Information Society and/or New Economy is being elaborated by TERRA's linked series of narrative scenarios and numerical models concentrating on identifying and expanding the most crucial aspects of the picture. This Dominant Relationships Modelling preserves scientific integrity (by modelling only that which may reasonably be measured or formalised and thus modelled). This is combined with a high degree of transparency (since policy recommendations will not normally be accepted, fruitfully debated or usefully acted on if they cannot be confidently understood by those to whom they are directed).

## 2.1 Support for Policy Making – TERRA results

From the previous diagram it is clear that many classes of 'evidence' have to be assembled by those who seek to offer advice to those whose task is the formulation of policy. Results of TERRA are grouped to correspond to these classes of needs:

Concept Sheets operate at the widest level, describing and explaining concepts that are common to the whole generality of IST's impact on S.D. (and so belong at the level of hindsight – indeed much of the material in them long predate TERRA). Topics covered by TERRA Concept Sheets are:

| | |
|---|---|
| 1 | What is Sustainability |
| 2 | The Relationship of the Information Age to Sustainability |
| 3 | Globalisation and the Network Society |
| 4 | Lifestyle, ISTs and Sustainability |
| 5 | Rebound Effects in the IST Context |
| 6 | Integration and Interconnection in TERRA |
| 7 | Resilience |
| 8 | Poverty and Equity |
| 9 | Human Capital |

Insight Primers operate more narrowly, describing and explaining mechanisms rather than concepts, and thus being entirely in the 'here and now', the area we call insight. Topics covered by TERRA Insight Primers are:

| | |
|---|---|
| 1 | ISTs and reducing environmental impacts |
| 2 | ISTs and reducing inequality |
| 3 | ISTs and increasing human ability and potential |
| 4 | ISTs and 'weak signals' of coming change |

## 2.2 Support for Policy Making – Briefings

The concept of Policy Briefing is necessarily reactive; and indeed generally reactive to circumstance and specific problems, so that the first basis of a Policy Briefing would normally be a request from a policy maker for support. TERRA as an RTD project did not have that framework in place, so that the policy issues raised in TERRA are those which appeared most substantial or most typical in the themes relating to man (human capital and equity) and his environment (energy use, recycling etc). These specific instantiations of support for policy making are summarised in, respectively, Sections 5 and 6 below.

# Section 3

## Tracking IST impacts on Society

# 3 Tracking IST Impacts on Society - Phases and Rebounds

## 3.1 Introduction

A considerable body of work already exists on the relationship between various actors in technological development[7] and the resulting nature and chronology of technological development. In its early stages, such development tends to focus on increasing process efficiency, subsequently passing through an 'endogenous innovation' phase of maximising the input of all actors within a community en route to an 'exogenous innovation' phase in which external interaction with other, not necessarily technological, communities is absolutely required for further innovation. TERRA clearly shows that work at the IS/SD interface (and indeed IST generally) is now at just that cusp where full engagement of external communities is necessary in order to progress.

The short-term competitive advantage produced by rapid increases in process efficiency at the early stages of IST was soon dissipated into a general commoditisation that lowered both prices and employment[8].

Current IST implementation is mostly concerned with endogenous innovation, which enables 'market-leadership' by full utilisation of human capital assets (hence TERRA's heavy emphasis on human capital issues). The appropriate analogy here would seem to be with Lifetime Learning – making the most of people's abilities but being flexible in doing it.

The future phase, exogenous innovation, will do new things altogether (see POTS and PANS below) and be concerned with invention and entrepreneurship: this gives some pointers for policy issues but is as yet only visible as 'weak signals'.

TERRA is particularly concerned with optimising the effects of introducing the new Information Society Technologies (ISTs). ISTs are the latest wave of innovation associated with an emergent general-purpose technology. The slow and uneven diffusion of such technologies and the resulting secondary innovation and wide range of socio-economic effects are often described as Kondratieff Waves[9]. Freeman and Louca[10] describe five waves thus:

[7] Described variously in the literature as communities of practice; textual communities; technological frames etc

[8] A simple analogy would be with TQM techniques where this effect has been very apparent.

[9] Among a vast literature on this topic, the very long historical perspective is covered well by Fischer (1996), and the parallels between ISTs and the Industrial Revolutions by Freeman and Louca (2001).

[10] Freeman and Louca (2001).

| | |
|---|---|
| 1780 – 1848 | Water powered mechanisation of industry |
| 1848 – 1895 | Steam powered mechanisation of industry and transport |
| 1895 – 1940 | Electrification of industry, transport and the home |
| 1941 - 1985 | Motorisation of transport, civil economy and war |
| 1985 - ? | Computerisation of whole economy - IST |

Of the past technological innovations, electrification and the development of rail travel seem most relevant to TERRA. Electrification combines the features of dematerialisation and network evolution and served as an enabler of ICT. The creation of railways and of railway networks combines networking content with the benefits of an immense literature, detailed data in enormous quantities, and wide conceptual accessibility to the layperson.

Following this particular analogy, consider what happened when the first railways came. Transport had existed before the railways: sea transport was cheap and efficient; canals less so; road transport less so again. Much capital had been invested in roads and canals (often with little return) and many individuals and enterprises derived their livelihood directly or indirectly from them. The construction of a new railway line involved large capital expenditure (and much use of materials and energy); on its completion, rates would generally be set below those for road or canal traffic (often quite artificially) so that the previous generation's capital investment was largely wasted whilst the new generation's investment duly failed to produce a return. The challenge posed by these new risks, in turn, catalysed the transformation of business enterprises and capital markets. In addition, the need to coordinate gauges led to one of the first 'standardisation battles[11]. Great social upheaval resulted, with fewer people employed per unit of transport - although, at least initially, more materials and energy were employed.

If that primary effect (a marginal and artificial cost reduction accompanied by great social and, in due course, economic distress) were the whole story, railways would have been very costly to society and to sustainability. The primary effect here *was* bad – but that rather misses the point. To quote Mathias (1983) 'the importance of the coming of the railways.... lies in the

[11] Puffert (2002).

fact that they enabled all other sectors of the economy to expand'. Here we have a simple dichotomy:

- Primary effect = bad
- Secondary effect = good

It is at least likely that this same dichotomy will apply to the introduction of ISTs.

Early discussions of environmental sustainability assumed (in accordance with the semantics of the metaphor) that rebounds were the bad result of a good intention; and that they were a secondary effect. Where primary = good and secondary = bad then no conflict exists in this understanding of rebounds, but technological innovation sometimes (and perhaps always) reverses this: primary = bad and secondary = good. We must conclude, therefore, that an unrelentingly negative understanding of Rebound will not suffice to describe ISTs' contribution to sustainable development, and that a more applicable and implementable understanding must be reached. Section 3.3 offers a treatment of Rebounds that makes no assumptions about primary or secondary, but merely distinguishes positive and negative effects. This removes the subjectivity of narrative discussion.

## 3.2 POTS, PANS, and Long Time Scales Between

In the 1980s, the great international and national telephone companies were full of talk about POTS (plain old telephone services) and PANS (the pretty amazing new stuff of digital services). Twenty years later, PANS are showing up on the market – although even now it is questionable if the mass of users has adapted its ways of living and working sufficiently to take full advantage. Into the simple development trajectories and smooth S-curves of theory, reality injects great longueurs and near-interminable delays. The benefits to society and to sustainability of the railways were seen to be a secondary effect – but it is also the case that they occurred relatively late in the day. Chandler and Hikino[12] propose, for example, that a major benefit in the U.S. was that railways *'provided the first example for the whole of the American business community of how to manage and run very large organisations'.* Freeman and Louca (op cit) suggest that *'they gave an impetus to qualitative and structural change throughout the economic system'.* These are slow-burn effects. So slow, in fact, that Fischer (1996) describes the era of the railways revolution in the U.K. as the ' Victorian Equilibrium', (i.e. the very opposite of revolution) within which (for example) price indices remained more or less static from 1800 to 1900.

[12] Chandler and Hikino (1997).

As an illustration of the very slow, meandering, and uncertain ways in which technological innovation produces its benefits, Lloyd[13] offers the following: *'It is a remarkable characteristic of builders of all ages to adhere to an established form of design, devised for certain materials, long after those materials have been superseded by others for which the traditional form is quite unsuited. Instances might be quoted from every age…. The continuance by the Greeks of principles of timber construction after timber had been abandoned for stone – e.g. the triglyphs of the Doric frieze are stone ornaments representing the ends of wooden beams'.* In fact, the Greeks never fully came to terms with stone technology (for all the wonders of their aesthetics, their trabeate form of building was essentially derived from timber columns and beams) and it was left for the Romans and, most gloriously, the later Islamic and Orthodox architects to develop the arches and domes that truly utilise the new stone technologies. In this case, many hundreds of years elapsed between the POTS and the PANS. This long-term view, when applied to ISTs, leads to the possibility that the largest effects of ISTs (for good or ill) may still be some way in the future and we may thus be premature in our expectations of benefit[14].

## 3.3 Dematerialisation, Immaterialisation, Amaterialisation

Notwithstanding these problems, previous thinking on rebounds cannot (and should not) simply be abandoned. The simple concept served a simple purpose well; future understandings are more likely to build on it than overthrow it. However, it will no longer do. In recent work on the Immaterialisation of Consumption, Simmons[15] argues for a distinction between the old understanding of the rebound to Dematerialisation (Rebound-D) as a price substitution effect, and a (new) Rebound to Immaterialisation (Rebound-I), which is an income effect. Quah[16] has expanded on the difference between 'embodied technical change' and 'disembodied technical change' in this specific technical IST-relevant context. Although Quah uses the term 'dematerialisation' in a way that includes immaterialisation, this conceptual expansion encourages tabulation thus:

| **Dematerialisation** | **Immaterialisation** |
|---|---|
| Efficiency | Innovation |
| Embodied technical change | Disembodied technical change |
| Improving existing things | Creating wholly new things |
| Doing old tasks better | Doing completely new tasks |
| POTS | PANS |
| Dematerialisation | Immaterialisation |
| Rebound-D | Rebound-I |
| Own price substitution effect | Income effect |

[13] Lloyd (1931).
[14] See further discussion in Section 7.3.
[15] Simmons (2002).
[16] Quah (1996).

| Quick action | Slow action |
|---|---|

The work signposted from Section 7 below outlines a yet further division to include the concept of Amaterialisation[17] and thus Rebound-A, bringing the treatment of rebound into line with that common in economic discussions of e.g. electricity prices. Policy issues relating to rebounds, and the crucial impact on policy of the actual time scale of social innovation related to technological change, are identified as central issues. The suggested techniques for dealing with them are themselves state-of-the-art but nonetheless identify areas where improved understanding is still needed.

[17] The principle of 'getting more of the same kind of goods and services from fewer resources' will ultimately become 'getting better and different welfare from less and more advanced use of material and immaterial capital." Amaterialisation is this deeper and wider transformation.

# Section 4

## Linking Past, Present and Future by Data Models and Scenarios

# 4 From Hindsight to Foresight via Insight

## 4.1 Lenses on the World

The world is uncertain and information is diffuse. To inform policy and discussions, various sorts of thinking/discussion aids, consistency checks and validation are necessary. In particular, understanding evolution of a complex system requires a combination of data, models and scenarios.

The development and use of these models in TERRA follows the TERRA backbone and takes place on several levels. Roughly, hindsight is based on databases and statistical analyses, insight is based on models and scenarios designed to describe the functioning of underlying mechanisms and their linkages and foresight is based on the use of such mechanisms to project (not forecast) the future evolution of the system (and the associated data and indicators) and the impact of policy levers under different circumstances.

Analysis begins with fairly simple statistical data summaries, high-level, aggregate and/or specific models[18] and scenarios and trends extrapolations – in addition to being essential precursors to more detailed analysis, they also help us to identify "things we didn't know that we knew." They also pose puzzles about phenomena that they can only render through assumptions, such as commoditisation of intellectual property, diffusion of new ideas, chains of secondary innovation, coevolution of network connections and cooperative behaviour, etc. On the other hand, they have the virtues of being explicit, easy to comprehend and (providing appropriate assumptions are made) reasonably robust ways of addressing the 'facts' and their implications.

By contrast, the world of ideas – and in particular the rendition of the 'hidden features' of the GNKS – is best addressed through more detailed[19] and disaggregated analyses. These are based on complex methods and are also more sensitive to assumptions and other uncertainties – they are a way of investigating "things we know that we don't know."

When considering the future unfolding of the GNKS, it is useful to distinguish models used for prediction, policy simulation and policy analysis. The first is primarily trend extrapolation and gives primacy to the data. The second incorporates policy levers into the structure to facilitate 'what-if' exploration of alternative policies. The third is exposes the mechanism underlying observed behaviour to logical scrutiny; any empirical estimation is driven as much by theoretical as empirical considerations.

[18] In particular, this includes the computational dominant relations and integrated models and the scenarios developed in the thematic work packages.

[19] More strictly, theoretical models are detailed in description of the underlying mechanisms, while computational (esp. integrated) models are detailed in scope.

Data[20] provide calibration, face validity and a sense of proportion. But their provenance and interpretation are influenced by definitions, coverage, collection methods etc. The other components (models and scenarios) help us understand what the data do and do not tell us, and unlock information hidden in them. The term typically refers to quantitative measures, but the underlying variables can be 'hard' (naturally quantified, objectively measurable) or 'soft' (only measured through indicators and/or subjectively defined). Scientists tend to think of data as being derived from the behaviour of an underlying (possibly complex and/or unpredictable) system.

Models help to unlock latent tendencies in data, test our understanding of system structure and dynamics, and discuss policy issues in ways that expose assumptions and rules of inference. Models can use and/or generate data, but not all models do so. As used here, the term model refers to a quantitative description of all or part of the TERRA system. As used in TERRA, models fall into three broad categories[21] as indicated in Table 1.

**Table 1: Model types**

| *Level* | *Purpose* | *Horizontal Span* |
|---|---|---|
| Conceptual ("what should be") | Sheds light on complex ideas lacking structure, data, etc.; guide lower level modelling, generate rigorous/ qualitative insight relating to general principles. | Features of 'deep' structure common to all thematic domains (e.g. networking, globalisation, etc.) |
| Policy-orientated ("what could be") | To give (external) meaning in terms of mechanisms and levers | Policy domains: decision proc., ministries, levers, jurisdictions |
| Outcome-orientated ("what would be") | Quantify/illustrate spillovers, support signpost/trigger planning, gaming, illustrate for wider audiences. | Linkages across IS↔ sustainability domains |

[20] Data sources described in "Tools and Models Final Report" and references therein.

[21] It is also possible to divide the models by form: i) *computational models* of varying degrees of complexity, completeness and fidelity to empirical data; *empirical models* designed to test specific hypotheses against real data and develop predictions from proven hypotheses; and *theoretical models* intended to derive useful conclusions from a set of starting assumptions and rules of inference.

These are not disjoint: Figure 1 shows how some of the models[22] developed in the TERRA project fit into this framework.

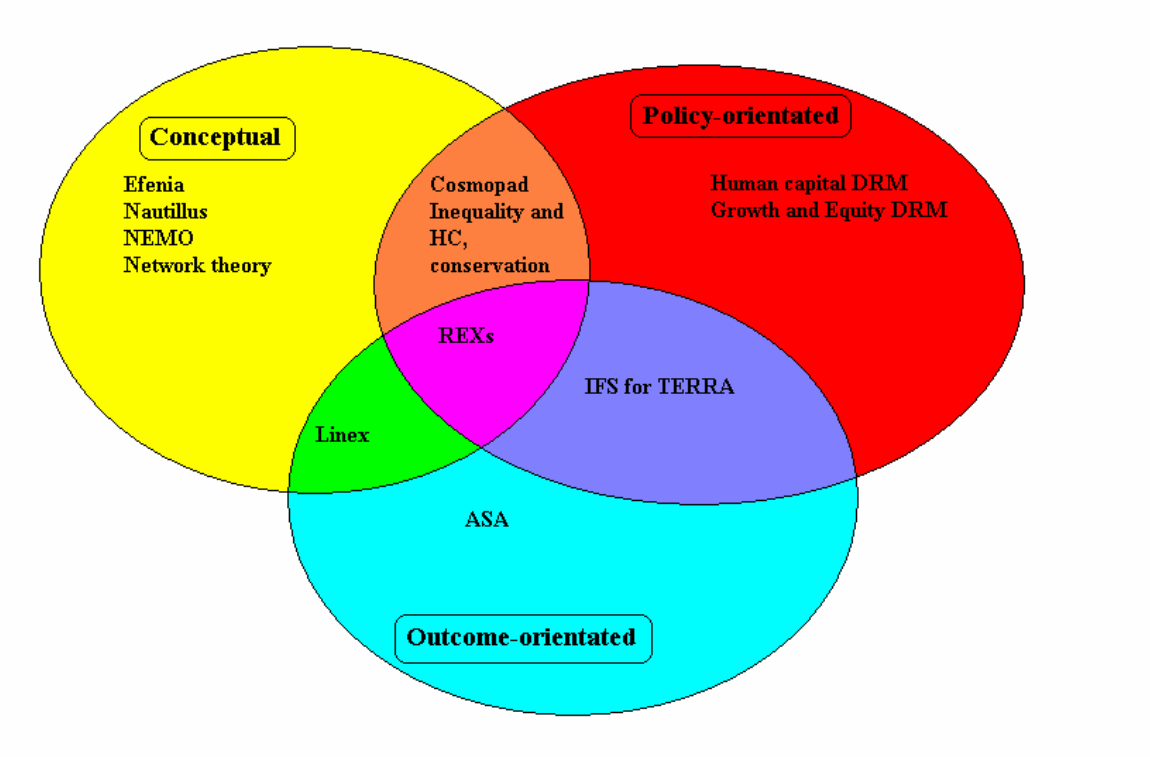



**Figure 1: Model types in TERRA**

As the perspective evolves from prediction to policy analysis, the tools evolve as well. As many of the phenomena tackled by TERRA are not readily measurable – and some are not even quantifiable in the usual sense – so not all the models are (or should be) at the same stage of development. It is no accident that the latter stages of the project saw an increase in the amount of paradigmatic and theoretical modelling, as this is the appropriate way to approach those fundamental developments that emerged as essential based on computational modelling and accompanying scenario analysis.

Scenarios provide a common basis for discussion and analysis, to ensure that progress towards understanding the strength and policy implications of the propositions is at the same time logically consistent, reasonably comprehensive, comprehensible and engaging for stakeholders, calibrated to real data where possible, appropriately sensitive to both hard and soft data and relevant to policy issues. They are thus a tool for exploring knowledge and improving coordination.

TERRA scenarios were used in various ways. They were used as a framing device for describing the current situation, identifying trends and possible

[22] More details on these models are provided in Table 2 below.

interventions, and making visible important criteria. This is particularly true of the Human Capital scenarios, in which the level of description was primarily numerical and based on explicit computations in order to provide a sense of the scope of the issues considered, quantify the direct and side effects of various specific policies and aid the search for attractive combinations of policies. The Equity and Growth scenarios were more explicitly laid out in 'scenario space' along two critical dimensions, but also made use of dominant relations computations to calibrate the 'storyline' and the powers of the actors. The Information Age Sustainability scenarios were described in terms of welfare and environmental stress dimensions, and scenarios developed along the lines of feasible trend extrapolation.

A further set of scenarios were developed with the integrated IFs model to track possible futures from an empirical point of view. This analysis was built up from the necessary conditions for sustainability in each of the thematic areas and an extrapolation of the requirements for achieving them and the spillover consequences. This therefore represents the 'virtuous corner' of scenario space.

Ultimately, the aim was to develop a comprehensive set of scenarios for interactive use in combination with a supporting set of models and exploration tools. In this ultimate view, scenarios provide a context for discussion to combine knowledge of participants whilst minimising impact of 'foregone conclusions.' A more active use of combined scenarios and tools is to facilitate interchange among experts through gaming. At the current phase of scientific and policy development, the greatest contribution of these efforts is to shed light on the relevant complexities of the central concepts of Globalisation, Networking, the Information Society and Sustainable Development.

## 4.2 Value of Multiple Long Data Sets

The phenomena studied in TERRA are connected to long-term trends and development, and therefore require a long perspective. On the IS side of the picture, much of what was written and concluded on the basis of short-term trends in e.g. productivity associated with the 'New Economy' turned out to be exaggerated – or were regarded that way when the 'dotcom bubble' burst. At that time, many observers concluded that the whole New Economy paradigm as an overblown fiction. Recently, econometric growth analyses[23] have begun to develop the framework within which long-term trends and trend-breaks can be distinguished from short-term cyclical or idiosyncratic behaviour. This discrimination is particularly apt for analysis of sustainability, which by definition addresses the medium- to long-term consequences of short-run behaviour. The lessons of history, too, direct our attention to long

[23] See esp. the 'Markov switching' literature.

time series and broad data sets; the initial and ultimate effects of any transforming technology tend to drive in opposite directions, and the long-term effects may be both a long time in coming[24] and spread through diverse parts of the world. This does not mean that near-term data are not appropriate: indeed, the acceleration associated with the IS[25] suggests both that some dynamics may be operating more rapidly and that responses to emergent patterns may change behaviour even when the 'fundamentals' have not changed.

## 4.3 The Strength of Soft Data

Many important features of the GNKS resist quantification or objective measurement. This does not diminish their importance either to the policy issues or to even quantitative scenario development. In particular, information on the distribution and evolution of values (as measured by surveys) are vital factors shaping the emergence of mass support for democracy, environmental protection, gender equality and other cultural changes; and the interaction of this support with political institutions and other structural factors.

Effective support for sustainable development requires political support for often-painful policies. This cannot be limited to backing for specific policy proposals. First, there are many steps between the initial conception and ultimate implementation of policy, and support from the public is required at every step. Second, policies work, or fail to work, in a context defined by other policies and individual behaviour. Support for sustainable development must be embedded in societal values rather than specific initiatives if meso- and macro-level actors (e.g. governments and businesses) are to achieve consistency and workable co-ordination. Moreover many aspects of the problems faced by the GNKS require changes in individual behaviour that can only partially be mobilised by external incentives. It has frequently been observed[26] that people say one thing and do another in matters of e.g. equity and the environment – this does not mean that speech and action are unrelated, but only that the relationship between them – which depends critically on communication and exchange of information and opinion – must not be taken for granted. This understanding is based in part on theoretical considerations (e.g. the evolution of conventions considered in the theoretical modelling) but equally on the empirical rendering and projection of value change.

The integrated modelling system (IFs for TERRA) considers change in three cultural dimensions identified by the World Values Survey (Inglehart 1997); materialism/post-materialism, survival/self-expression, and traditional/secular-

[24] Impacts of 19th century developments relating to steam and electricity are still unfolding.
[25] Berg (2001).
[26] See e.g. Schauer (2003), Kaivo-Oja, *et. al.* (2003).

rational values. These are measured by a wealth of variables. The TERRA data set includes a subset most directly linked to the key dimensions of cultural change, together with such additional substantively interesting variables as a society's attitudes toward state ownership versus private ownership or support for democratic institutions. Factor analysis of the WVS data showed that the survival/self-expression, and traditional/secular-rational dimensions span the space, while materialism/post-materialism tracks a curved path through this space followed by the cultural development measured in the survey.

In addition, the project also collected survey data relating to Information Age involvement of civil society actors, notably NGOs. These data shed light on changes in values and on the linkage from values to actions - while these are inherently conceptual matters; there *are* valid indicators that have proven valuable in quantitative relationships, as indicators in semi quantitative and scenario analyses and as calibration points in discussions and debates.

## 4.4 Models

As mentioned above, TERRA undertook a broad range of modelling activities. An overview of most of the computational models and their relation to one another and the overall project is provided in Hughes, *et. al.* (2003b). This section provides a summary of that structure extended to include the theoretical models.

In TERRA, models were used all along the 'backbone.' For hindsight, the main integrated model (IFs for TERRA) and the related indicator-based model focussing on sustainable development (ASA) provide comprehensive tools for exploring the past and the *status quo*. Of course, the empirical models (esp. Linex and the panel equations estimated for the study of the relation between human capital inequality and growth), being estimated using historical data, provide summaries of past outcome and trends.

**Table 2: classification of some principal TERRA models**

| *Model* | *Type* | *Focus* |
|---|---|---|
| Conceptual System Dynamics Model of Planetary Agricultural & Biomass Development (COSMOPAD)[27] | Computational - Insight | Human-induced worldwide biomass production and its effects |

[27] See Weiler and Tesch (2003).

| *Model* | *Type* | *Focus* |
|---|---|---|
| Effects on Environment of Internet Applications (EFENIA)[28] | Computational - Insight | Environmental requirements of key elements of GNKS infrastructure for IT applications |
| Networking Effects Model (NEMO)[29] | Computational - Insight | Examination of competing SD paradigms: constraints and technological potential |
| Dominant relations human and social capital model(s) (DRM)[30] | Computational - Dominant relations | Foresight into power of immigration, education, and growth in labour productivity to overcome projected skill shortages and examination of social capital and equity development. |
| Advanced Sustainability Analysis (ASA) | Computational - Integrated | Crosscutting SD analysis based on 'master equations' relating welfare and environmental stress to indicators of economic, technological and social development. |
| Collective Modelling Platform | Computational - Integrated | Collecting and integrating systems dynamics models |
| IFs for TERRA (IFs) | Computational - Integrated | Large-scale integrated global modelling system adapted to GNKS features and policy levers. Serves data exploration and scenario development/analysis. |
| Resource Exergy Services (REXs) | Empirical - Integrated macro econometric forecasting model | New formulations of important components of economy-energy models: capital accumulation, resource use and technology-innovation |
| Linex macro production function | Empirical | Accounting for role of physical work in growth |
| Human capital inequality model | Empirical | Panel model of relationship of human capital inequality to growth. |
| Network structure, behaviour coevolution | Theoretical | Game-theoretic model of evolution of co-ordinated behaviour and network structure, used to analyse network aspect of SD |

[28] See Tulbure (2002).
[29] See Tesch and Descamps (2001).
[30] See Mesarovic *et. al.* (2003).

| *Model* | *Type* | *Focus* |
|---|---|---|
| Inequality and conservation | Theoretical | Game-theoretic model of inequality and conservation of commons |
| Networking Activity Understanding and Testing Instrument Linking Logic reasoning and the Use of Simulation (NAUTILLUS) | Theoretical-computational | Simulation tool for examining growth and properties of random networks. |

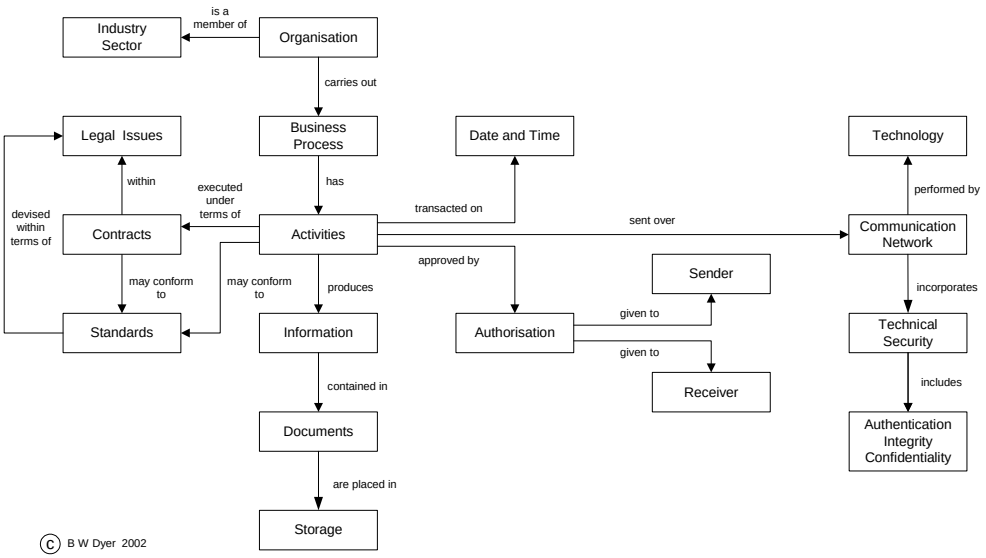
Integrated computational models

Computational models produce numerical outputs, and are thus appropriate for engaging with stakeholders whose actions rely on quantitative representations of the *status quo ante*, the impending future and the impact of policy options. These models include integrated data/indicator models used to give a broad view over the holistic evolution of the Information Society. The underlying framework is IFS for TERRA, based on the International Futures (IFs) model. This system combined a very wide range of data with sophisticated multi-sectoral modelling to provide a tool for exploring both the past and the future. For TERRA, this was modified in order to highlight the centrality of the GNKS, to provide a 'policy cockpit' for exploring the impact of policy scenarios and the design of adaptive multi-policy programmes. A related view concentrating on indicator-level description of sustainable development is presented (within the overall framework) by the Advanced Sustainability Analysis (ASA) approach, which rests on two basic postulates for improving sustainability: non-decreasing welfare and non-decreasing environmental stress. Conditions suitable for empirical analyses and policy formulation are derived mathematically from four identities ("master equations") that relate the environmental stress variable (ES) chosen for an analysis to the basic indicators of economic, technological and social development. The explanatory power of the theory relies on new concepts and formulas for sustainable policy making and new empirical results for comparisons among countries and regions as well as between policy targets and results achieved. The use of such identities in ASA and other 'dominant-relations' type models necessarily abstracts from the specifics of 'bottom-up' behaviour. In complex, multi-layer system and broad range of actors make interlocking decisions that determine overall system behaviour over time. Dominant relations models and trend analysis provide descriptions of this behaviour. Explanation uses models estimated from empirical data to test theoretical formulations of dynamic behaviour. Within the TERRA system of models, such explanation is provided (in an integrated, sustainability-orientated sense) by REXs.

What the different types of models tell us

The TERRA computer modelling toolkit contains models at three levels: paradigmatic, dominant relations and policy-analytic. These names combine different characteristics, so a word of explanation of how they interact is in order. Essentially, the paradigmatic models are used for 'playing with ideas' to investigate the implications of different ways of formalising concepts (networking, globalisation, immaterialisation, etc.) that are difficult to measure and which lie well below the level at which data are collected, see, for example the 'Entity Model for Information management' below.

**TERRA 2000**
**Network Effects Model**
**Entity Model for Information Management**




Dominant relations models are based on accounting identities[31], and are used to identify major trends and draw attention to areas requiring specific investigation. For instance, Section 6 discusses a characterisation of sustainability in terms of abstract measures of welfare and environmental stress. These can be linked to a range of indicator data. One particular aspect is the linkage between economic growth (which feeds incomes and thus welfare) and environmental stress. This linkage is sometimes addressed in terms of derived indicators like eco-efficiency, which in turn can be measured using other data. This sort of investigation allows broad comparisons and trend identification, but also points towards the need for specific types of refinement. In particular, the aggregate picture abstracts from or places an envelope over the complexities of individual and system behaviour. In order to focus on mechanisms of policy action, understand trend-breaking

[31] This does not imply that DRMs are limited to aggregate data. The Human Capital DRM discussed in Section 5.2 is largely disaggregated along national and sectoral lines, while the ASA DRM discussed in Section 6.2 concentrates on aggregates.

developments take account of rational behaviour or changes in the way individuals interact, and in order to accommodate the resulting dynamics, it is necessary to construct more detailed, dynamic and behavioural models, whose parameters are typically estimated econometrically. The outcomes can thus be quantified fairly precisely, as can the associated uncertainty.

## 4.5 Scenarios

This section discusses the uses of scenarios within the project. It draws on the first scenarios document, and adds text explaining why the different thematic efforts each developed their own scenarios, how they are broadly consistent with the crosscutting themes (dimensions) of the SOT, and why integrated scenarios should await further development of the propositions.

A scenario is a partial description of a set of possible futures based on a description of the *status quo ante*, a set of actors (with motivations, powers, and information), a system (with well-defined boundaries and mechanisms), and specific dimensions along which it is described or tracked. The narrative core of the scenario constitutes an implied storyline about future evolution, which may include branches and critical uncertainties. Scenarios should be described in concrete terms, be internally and logically consistent, and illustrate the major issues. As predictors of the future, their only common feature is that they are false in detail. As a result, multiple scenarios are preferable to single ones, and their construction is not only non-trivial, but may prove to be more important than the end result. Ultimately, therefore, they must be experienced interactively.

A set of scenarios can be described by a common *status quo* ante, and variations on four main elements[32].

- Exogenous or uncontrolled *uncertainties* that are at least potentially important - these are the main features distinguishing different scenarios. In some instances, the scenario development is orientated along policy lines, or expressed in terms of success (or otherwise) in attaining specific policy targets, but this implies uncertainties relating to the underlying mechanisms or drivers.
- Policy levers that can be adjusted or debated by scenario users - in most cases, and particularly for the Growth and Equity and Information Age Sustainability frameworks, the emphasis is on the effects of policy or the endorsement of policy targets rather than specific policy mechanisms, but this implies the use of specific policy instruments.
- Mechanisms or relationships among the factors – these range from

[32] This framework owes much to the XLRM framework developed by Lempert, Popper and Bankes (2003).

aggregate-level descriptions of the necessary logical connections among the main indicators to specific behavioural models and from relationships calibrated to or estimated from real data to paradigmatic or theoretical models. The responses of other actors to policies and the resolution of uncertainties should be seen as part of the underlying mechanism.

- Indicators by which scenario evolution is tracked and performance evaluated.

The inclusion in all scenarios of important factors whose values are known or can be predicted is important to ensure acceptance and relevance. Less important known factors can be included to make the scenario seem more concrete and relevant. The factors that are at the same time uncertain and important define the dimensions of 'scenario space' – they differentiate the scenarios from one another. Uncertain factors of minor or narrow importance are included to give colour and life to the scenario and to serve as the springboard for 'weak signal' analysis of developments whose likelihood and importance can be imagined but not assessed.

**Table 3: Elements of the main scenario frameworks**

| *Scenario Framework* | *Uncertainties* | *Policy levers* | *Mechanisms* | *Indicators* |
|---|---|---|---|---|
| Human Capital [Section 5.2] | Output, consumption growth, population | Investment, education, migration, outsourcing, labour productivity | Aggregate dominant relations focusing on global ICT sector, paradigmatic model of network economy. | Skills supply and demand, consumption, unemployment, population (size, migration), GNP growth, trade balance, social support. |
| Equity and Growth [Section 5.3] | Internalisation of ecological constraints, consensus/human-rights-based governance | Market mechanisms, co-financing, global contract, security measures, trade/aid requirements. | Dominant relations among prosperity, equity, human domination of the earth, 'Information Age' | Equity value, GNP growth, Global Hectare Equivalent, carrying capacities |

| *Scenario Framework* | *Uncertainties* | *Policy levers* | *Mechanisms* | *Indicators* |
|---|---|---|---|---|
| Information Age Sustainability [Sections 6.2 and 6.3] | Dematerialisation, rebound, economic growth | Factors affecting dematerialisation, immaterialisation, rebound effects, welfare productivity of GDP, IS development | Indicator-based models of interrelated economic, population and material intensity changes, Macroeconometric growth model, paradigmatic agriculture model | GDP, environmental stress, population; dematerialisation, immaterialisation, ASA-sustainability, energy use, land requirements |
| TERRA apocrypha [Section 5.3.6] | Separating weak signals from noise, emergence | Potentially, all. | Coevolution of network structure, flows, behaviour of networked entities; emergent behaviour, innovation | New indicators relating to network structure, efficiency, equity, resilience |

Because scenarios are experienced individually, but identified and interpreted collectively, the relationship of a set of scenarios (or 'scenario space') helps to distinguish scenarios from mere projections. Since a scenario does not completely describe the future, it partially describes many possible futures. Ideally, a set of scenarios should be constructed, differing along a few dimensions or possibilities that highlight important features of the analysis. In the TERRA project, the main dimensions are:

- Globalisation/networking: whether worldwide flows (of people, ideas, resources, economic activity, etc.) continue to increase in extent and complexity;
- Integration: whether internalisation and cooperation characterise the world order; and
- Division: whether 'divides' based on digital access, income, education, access, etc. increase.

Not all the logically possible alternatives are relevant – in particular, it seems fairly obvious that globalisation will proceed, although its equity, inclusiveness and efficiency are open to debate and analysis. Moreover, the scenarios developed for the specific thematic analyses (Human Capital, Growth and Equity and Information Age Sustainability) framed and interpreted these dimensions in slightly different ways. This is a natural consequence of the role of scenario space in highlighting relevant features.

## 4.6 Use of these Components Within the Project

The TERRA project architecture combined modelling with scenario development and analysis and combined forecasting with backcasting[33] in an iterative fashion. To start the iteration, the underlying concepts (see esp. section 2.1) were clarified, the unfolding situation was assessed using the integrated model[34] and these elements used to define the propositions (Sec. 1), the three thematic lines of development (Secs. 1.2, 1.3, 1.4) and the three overarching scenario dimensions just described.

Within each theme, initial scenarios were developed to identify the key variables and relationships and the appropriate modelling developments. As the model results were incorporated into the scenarios, further suggestions for modification of the modelling structure were derived and instantiated. For this reason, some of the more theoretical and complex models have only now begun to emerge – this is consistent with the interactive nature of the exploration, the need to provide insights at different levels of the policy process and the specific interests and expertise of the consortium members.

The initial scenarios were based on forecasts or trend extrapolations. Where the issue and level of detail warranted, these were refined to take account of specific mechanisms, possible shocks and policy levers (particularly in the dominant relations models). Roughly, these models and the scenarios they inform are stories about the development of the GNKS. At the same time, the focus on sustainability (with its emphases on the medium-to long-term view and on resilience to shocks) and on global issues called for the formulation of 'landing-place' scenarios; stories about where the GNKS might arrive eventually. The analysis of such scenarios is more of a backwards-looking exercise to identify sufficient and necessary conditions for reaching the landing place (with sufficiently high likelihood). To test these conditions, further forecasts should be performed – the overall 'bouncecasting' process helps to effectively narrow the gap between positive and normative scenarios and build a common understanding of appropriate steps to take forward into policy.

The following two sections give examples of this process in action. Section 5 starts from an issue relating to human (initially economic) concerns and develops the analysis of member-state or EC concrete policy options in response to that issue. Of course, these 'solutions' raise wider societal concerns, which must be addressed by 'policy' at a different (more global, more fundamental) level and thus call for a different style of analysis (though one based on a consistent understanding of the world). Along the way, other

[33] See Mesarovic (2003), Kaivo-Oja, *et. al.* (2003), and TERRA (2002a) for descriptions the distinction between forecasting – and forward-looking (positive) scenarios – on one hand and back-casting – and backward-looking (normative) scenarios on the other.
[34] Hughes (2003a).

specific issues were identified and analysed, which deepen our understanding, engage stakeholders from a range of disciplines and point the way to a more nuanced debate as better data and tools are developed.

Section 6 follows the analysis of scenarios relating to sustainability in a system-wide sense centred on human interaction with the environment. It begins with a top-level view of sustainability based on global aggregate data and the dominant relations that must exist among them. This leads to the elaboration of fore- and back-cast scenarios and policy guidance in terms of the directions in which these high-level indicators *must* evolve. This accomplishes two things: to neatly identify a set of problems and to set the common boundaries of an overall policy framework for application both within and among nations. To go further, we are led to ask *why* do we see the behaviour that we observe, *what* is the nature of its evolution (as a system with internal and external feedback loops and based on imperfectly rational human choices) and *how* (at a precise level) can we intervene to assist that evolution.

It is worth noting that the policy issues considered in Section 5 flow from disaggregated, short-term concerns to their aggregate medium-term spillovers, while those considered in Section 6 start with the aggregate medium-to-long-term sustainability problem and work back to a more explicitly dynamic and disaggregated perspective.

Section 7 picks up the weak signals aspects of the framework by relating the thematic scenarios to the three overall dimensions and developing the analysis of underlying aspects of the GNKS that are either resistant to measurement or difficult to reconcile with numerical models.

# Section 5

## Examples of Policy Issues Relating to Man qua Man

# 5 Policy Issues Relating to Man *qua* Man

## 5.1 Wealth and Welfare

When the sustainability debate turns itself to issues of mankind *per se* (as opposed to man's impact on his environment), attention is naturally directed to 'welfare' – particularly to health, life expectancy, happiness, dignity and economic well-being, among other criteria. This is a broad topic indeed: from a numerical analysis standpoint, most (arguably all) data have some bearing on the subject; if treated in narrative most (arguably all) of the literature of mankind might fairly be called in evidence.

This gigantism of the topic is not unique to TERRA and many techniques are available to cope with it; much of the work described in this section uses aggregated proxy indicators (and the distribution of values within these aggregates) and dominant relations analysis as reduction techniques.

The most widely used reduction technique is aggregation of elements into broadly defined 'Welfare' concepts and their use to create indices (the Human Development Index; the Index of Sustainable Economic Welfare etc). Of all such aggregates the simplest and crudest is also by far the most commonly used: income (most commonly per capita GDP). This is used to proxy many quite remote considerations (happiness, for instance) and is so commonly used for this purpose that wealth and welfare are, for some politicians, interchangeable: 'it's the economy, stupid'.

Within this gross but useful simplification[35] of human aspirations, TERRA has concentrated on the most natural sub-divisions –*creation* (efficiency) and *distribution* (i.e. equity within and between populations) of wealth/welfare. The obvious third sub-division that completes the triumvirate, *maintenance* of wealth/welfare, is naturally related to sustainability (see Section 6). *Creation* and *distribution* are sufficiently acute (and current) that we concentrate on them for the balance of this section and ignore 'maintenance', the warnings of Gibbon notwithstanding.

Some of the numerous analytical and modelling tools and techniques demonstrated in TERRA work almost exclusively with aggregate proxy indicators – and tend as a result to be suited to global structural questions.

[35] In defence of this measure, note that data on material welfare are typically unavailable; even data on wealth (indicating command over goods and services) are not widely or consistently collected. Moreover, money serves as a useful aggregator of preferences under ideal market conditions for those aspects of human welfare tied to market-distributed things. In other words, while welfare is best conceived as an ordinal concept that does not admit interpersonal comparisons, ideal market trades do lead to situations where willingness-to-pay, money metric utility and simple notions of fairness can be implemented.

This is particularly evident with the ASA material discussed in Section 6 below. Other techniques - particularly those discussed in this section, apply to distributions within the aggregates – and in consequence allow local or sectoral views within the bigger picture.

Linkage across TERRA analyses is illustrated by a specific policy problem relating to the GNKS: the demand for and supply of skilled labour. Section 5.2 considers this as a distributional issue from an economic perspective, concentrating on direct and specific policy instruments. The impacts considered emphasise European concerns. Of course, this is not the end of the story – the creation and employment of various types of human capital changes income (and welfare) distributions among nations, among skill levels within a nation and even within skill levels (see Section 5.4.3 for more on this). The considerations raised by changing patterns of (in) equity are considered in Section 5.3, in relation to the more indirect policies appropriate to the global scope of these issues. Section 5.3.6 reports some related modelling and analyses that provide alternative viewpoints, insight into (two-way) linkages between efficiency and equity and a window into an analytic future where such issues will hopefully become more tractable.

### 5.1.1 Human capital

TERRA thematic analysis uses the term Human Capital more to encapsulate the causes and results of the creation of wealth/welfare than as a precise formulation[36]. It thus embraces productivity, efficiency, innovation and competitiveness issues central to industrial policy, and also skills, intellectual policy and network issues that characterise the interplay between Human Capital and the GNKS[37].

### 5.1.2 Equity

The term Equity is also used in rather generic fashion to encapsulate the characteristics and implications of differing wealth/welfare distributions It thus includes (absolute and relative) poverty concepts, the infinite gradations of statistical income distributions (as proxy for wealth/welfare); the endless dichotomy between fairness and diversity (the post-material dialectic) and the eternal reminder that fairness takes a back seat to survival so different 'rules' apply near the boundary of absolute poverty[38]. The development of this in TERRA is illustrated in section 5.3 below.

[36] Empirical work on human capital inequality uses the measures of educational input and certification; despite their well-known deficiencies, they are at least available.
[37] Cave (2002a, 2002b), Cave, Hughes and Mesarovic (2002).
[38] Conversely, fairness considerations become more important when inequities are very great – even more important than survival in some cases.

### 5.1.3 The GNKS and sustainability

The debate about Human Capital, Equity and the GNKS is (despite its great potential for benefit) merely the latest iteration of an age-old story of human progress. In this latest context monetised values proxy the creation and distribution of knowledge and understanding. The Information Revolution puts a heavier emphasis on the valorisation of abstract 'thought' (e.g. as IPR) than has been seen before – but this follows the pattern of the Industrial Revolution, which put a heavier emphasis on the valorisation of concepts as 'things' than had been seen before -and which itself followed the pattern of the Agricultural Revolution, which valorised the very earth itself in ways that were, at the time, equally extraordinary and alien. Paradoxically, TERRA's work on the GKNS thus necessarily includes a long retrospective view, also summarised in section 5.3.6.

## 5.2 TERRA's Work on Human Capital

As an example, the following policy issue, scenario computations and policy recommendations are paraphrased from the TERRA report on 'European Policy Options for Human Capital Enhancement'.

A defining characteristic of the first half of the 21st century is exponential growth in knowledge and information. Human capital is overtaking physical capital as the predominant source of growth in developed countries. "*Knowledge and information is being produced today like cars and steel were produced a hundred years ago.*[39]*"* Intellectual rights are increasingly traded instead of physical products.

A recent study by *Alfred Herrhausen Geseltshaft*, using data on annual costs of education, computed German human capital at €12.4 trillion in the year 2000; and predicted that it "will never be the same", declining to €8 trillion by 2050. By way of comparison, using the estimated German capital output ratio of 2.5 and GDP in 2000 of €1.8 trillion, physical capital is €4 trillion Euros. Human capital per capita thus amounts to about €250000.

Demographic reality facing the European Union constrains the availability of human capital and therefore economic growth. This is particularly acute for ICT and other knowledge-based sectors needing a labour force with tertiary education, where innovation rather than skill alone is the key to success[40]. According to the Volker Jung, President of BITKOM, *"Computer companies in Germany are unable to fill some 75,000 jobs and the demand for specialists is expected to increase to 300,000 by 2003. At the same time, the German*

[39] Stiglitz (1999).

[40] A more detailed treatment of the implications of knowledge intensity for growth can be found in Cave (2003b).

*educational system produced just 10,000 qualified people in 1999."* The situation is exacerbated by global human capital scarcity. According to Indian Government sources, for example, shortages extend even to science and mathematics teachers with professionals migrating to ICT specialisations in the country and abroad[41].

### 5.2.1 Scenario analysis of EU policies in the global context

To give a flavour of the approach and relevant results, this section analyses EU policy options to secure necessary human capital . The EU policy objectives addressed include:

- Secure human capital to achieve EU development and growth objectives.
- Take advantage of foreign human capital investment[42].
- Reduce unemployment.
- Monitor and rationalise outsourcing of high-level ICT R&D and innovation akin to widespread outsourcing in manufacturing.
- Enhance social capital as the *"glue that holds society together."*[43].

Progress towards these objectives is measured by:

- ICT human capital deficits
- Immigration of highly skilled professionals
- Acceptable level of ICT industry R&D outsourcing
- Social contract
- Unemployment
- Economic growth
- Balance of trade
- Sustainability

The time horizons for analysis are 2025 and 2050. Because the problem stems from mismatched levels and location of work and skills, the policy levers can be framed as:

- Bring skilled people to the work –essentially a '*business as usual* (BAU) scenario in which labour productivity grows at 1%/year[44];
- Increase local supplies of skilled personnel – the *education scenario*, in which, following IIASA[45] tertiary education is assumed to rise from 17% in 2000 to 34% in 2050;
- Increase investment in innovation to raise productivity (e.g. by 'smarter,'

[41] This is an example of a negative feedback; today's demand destroys tomorrow's supply.
[42] Competition for human capital in the first half of the 21st century will be as intensive as was the competition for financial capital in the second half of the 20th century.
[43] Puttnam (2000).
[44] This reflects detailed assumptions about the pace, type and profitability of innovation based on recent experience. Cave (2003b) discusses the foundations in terms of a Schumpeterian view of growth slowed by the need to adapt as well as adopt.
[45] Lutz and Goujon (2001).

less skill-intensive technologies) – in this *labour productivity scenario* investment in knowledge acquisition based labour productivity is increased sufficiently to remove the need for human capital imports by the end of the time period; and

- Send the work to the people – in this *outsourcing scenario* up to 35% of ICT sector activity is relocated outside the EU to eliminate the need for human capital imports by the end of the period.

For quantitative scenario analysis using the dominant relations model[46], four scenario families were considered, corresponding to the following questions:

- How difficult is the problem?
- How robust are the policies to contingencies outside of those originally envisioned?
- How can stakeholders become involved in policy development?

Figure 2 shows the annual and cumulative inflow of foreign professionals relocating to the European Union under four policy options for the first of these scenario families (*Extent of the Problem*).

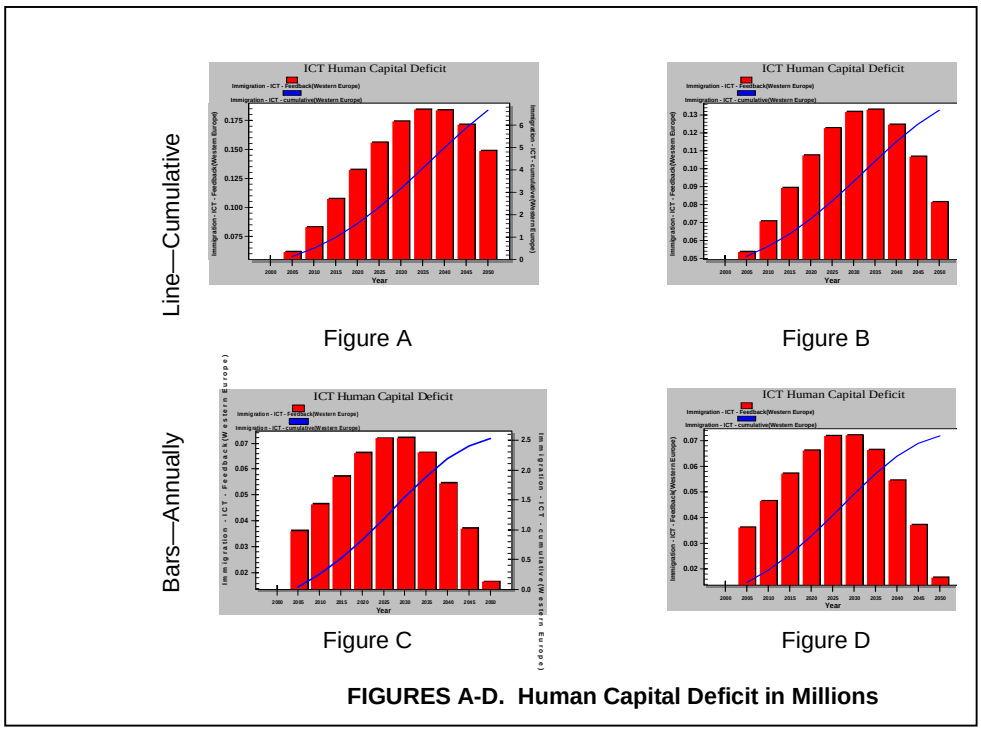



**Figure 2: Four 'Extent of the problem' Human Capital Scenarios**

Figure 2A shows the 'business as usual' scenario; no specific actions are taken to raise investment in domestic human capital. Cumulative immigration of

[46] See Sec. 4.4.

human capital in this scenario reaches 5.2 million people over 50 years due mainly to the weak growth of domestic human capital.

Figure 2B shows an *Education* scenario. Cumulative immigration of highly trained professionals reaches 4.8 million—just below the previous scenario. Education alone cannot achieve the objectives without levels high enough to call into question the logical consistency of the scenario.

Figure 2C shows a *Labour Productivity* scenario. Cumulative immigration is reduced to about half of the BaU case—2.5 million.

Figure 2D shows an *Outsourcing scenario*. The impact on human capital imports is analogous to labour productivity.

5.2.2 Some policy implications

Highlights of the analysis include:

- A policy portfolio judiciously selected to meet multiple policy objectives via participatory time-incremental scenario analysis process is a prerequisite for meeting the human capital challenge. Participatory scenario analysis offers the best prospect for public acceptance and support.
- Immigration of high tech professionals has to be part of the policy package. It provides a range of economic benefits: increased prosperity through economic growth accelerated by technology diffusion throughout the economy; meeting EU needs for highly skilled professionals by effectively mobilising foreign investment in EU human capital[47]; and potentially positive multiplier effects on employment to meet support needs of relocating professionals and families. The societal impact of immigration, of course, has to be addressed separately.
- Complementary outsourcing provides more local societal and economic negatives than immigration. Outsourcing highly skilled work that cannot be done locally supports complementary lower skilled local employment, which may help lower-skilled workers to find employment more readily than they would if global competition threatened e.g. manufacturing. It can also help EU-based companies financially through (limited) positive impacts on economic growth. Outsourcing of lower-skilled work may increase the private and social returns to (and investment in) local human capital, but may at the same time make lower-skilled and/or less able individuals worse off.
- ICT adoption has many effects on unemployment. Employment increases

[47] This also brings potentially positive spillovers: 'demand-pull' improvement of world-wide education and increased willingness to invest in foreign education by EU governments and businesses.

with high growth rates, though outsourcing cannot but increase short-run unemployment - though this is partially compensated by rebound effects – e.g. increased profitability of EU private sector. Longer-term structural readjustment may produce long-term unemployment. Human capital imports have both interesting and controversial impacts. Immigrant professionals and entrepreneurs increase growth both directly and through the competition their presence provides. Furthermore, the support and services they require generate secondary growth. The scenario computations show the reduction of unemployment due to this rebound effect.

- Higher education is always considered expensive. Yet, viewed in the context of lifelong learning and for the total labour force, the cost of university education is not prohibitive.
- Finally, from a societal point of view, the positive and negative impacts of high- and low-skill immigration and outsourcing are likely to be very different depending on, for instance, the degree to which the social fabric is eroded or strengthened by cultural and ethnic differences on one hand or unemployment and skill obsolescence on the other. Clearly, dangerous combinations are possible – for instance if poorly-coordinated immigration, outsourcing and education policies lead to cultural disruption combined with unemployment and a lack of support for individual and societal effort. On the other hand, these policies can be 'recoupled' to reverse the effect: for instance, immigration can reinvigorate local values (by participation) and revitalise local culture, while at the same time increasing economic productivity and welfare, and encouraging both technical and social education (as was the case during the 'Golden Age' of US growth during the late 19th and early 20th centuries). Remittance incomes and overseas employment can, as part of the same process, stabilise the 'source' regions and reduce current security challenges.

As mentioned, pursuit of these policies has a number of spillover effects. Some TERRA work concentrates on the specifics of human capital and its impact on growth and income distribution, taking up results from the literature on endogenous growth and conditional convergence. In summary, the results show that increasing levels of inequality among countries, between skill levels and within skill levels can be accounted for by incorporating into traditional trade and skill-biased technological change models three features specifically associated with the GNKS. These are the spread of *networking* with its tendencies towards winner-takes-all 'tipping' equilibria, increased *globalisation* and reduced communication costs, which increase the strength and volatility of international realignments in response to emergent technologies and the process of creative destruction as applied to general purpose technologies which diffuse through the economy in fits and starts, rewarding flexibility and incurring adaptation costs which slow measured growth. The upshot of these analyses is the conclusion that increasing inequality reflects both the direct result of *laissez-faire* market-mediated unfolding of the GNKS and an unintended consequence of both domestic and

foreign policies that are insufficiently GNKS-aware. It is to the broader issues of equity that we now turn.

## 5.3 TERRA's Work on Equity

TERRA did substantial policy-orientated scenario analysis relating to the relation between equity and growth. This analysis[48], summarised in sections 5.3.1 to 0, points out some striking patterns in the development of equity patterns and their observed relationship to GNKS access. These lead to specific policy prescriptions but, in addition, point the way to a deeper consideration of whom such prescriptions should be addressed to. Equity and growth are systemic properties and reflect both system dynamics and collective decision making – or governance. Some of TERRA's theoretical analysis draws connections between GNKS *outcomes* and GNKS *institutions* that link the scenarios (reflecting empirical data on outcomes) to the deeper literature on the societal evolution of the GNKS. These considerations, based on network modelling, are sketched in Section 5.4 (esp. 5.4.5).

### 5.3.1 Some striking facts

770 million humans on Earth are undernourished and 11 million children die from malnutrition every year. 1 billion people are overweight and 300 million are clinically obese.

The three wealthiest people on our planet had a combined wealth of $121 billion in 2001, which equals 10 years' gross national income of the 125 million inhabitants of Democratic Republic of Congo, Burundi and Ethiopia.

### 5.3.2 Poverty thresholds

The first problem the analysis confronts is the measurement of poverty and wealth. Various concepts lead to very different results.

Absolute poverty concepts have been used in the United States since the 1960's. Four food plans were computed: liberal, moderate, low-cost and economy (cheapest). The cost of the economy plan (multiplied by 3 to include non-food needs) defines the (annually adjusted) poverty threshold. In 2001, when the poverty threshold for a family of four stood at $17,960, 32.6 million US residents (11.7% of the population) were officially poor. Another focal absolute poverty level is a disposable income of $1[49] per day. Presently, 54

[48] Based on TERRA D14.1, Equality and Diversity in the Information Age.

[49] We use purchasing power parities (PPP) to correct for international differences in price levels. GDP measures the total value for final use of output produced by an economy. PPP adjusts GDP for the relative purchasing power of different currencies. It values all goods in U.S. prices and measures the units of a foreign country's currency required to purchase the identical quantity of goods and services in the local market. However, the basket of goods – assumed constant across countries – may include non-traded goods (precluding arbitrage),

million people (82% of the population) in Ethiopia fit this definition of poverty. One disadvantage is that such measures are highly sensitive to price information and availability of non-priced goods and do not take full account of discrimination based on relative standing.

Relative poverty measures tend to be more prevalent in e.g. European poverty measurement. According to this perspective, poor people fall below a specified share of average or median income[50]. This measure depends on the general level of wealth in a society and reflects the psychological impact of comparisons to one's reference group, and thus that absolutely wealthy people may experience discrimination when their standard of living deviates significantly from the local standard. The most commonly European reference point puts the cut-off at 60% of median income (Eurostat 2000). About 18% of the European population live below this level. The disadvantages of relative poverty concepts include the difficulties of comparing data from different countries and the very different faces of poverty. People who are classified as poor in one country may have a better life than the rich in another country if the average or median incomes of the countries differ a lot. For example, Luxembourg has 12% poverty according to this definition while Portugal has 23%. However, in Luxembourg the poverty threshold is €12,060 compared to €2,870 in Portugal. In the single European market, international price differences are rapidly disappearing[51], so the absolute measure is also relevant to understanding the situation of the poor in Portugal. It is just such disparities between absolute and relative poverty and the impact of changing comparison groups that lie behind some of the growing discontent with global market-mediated capitalism and consequent social unrest and migration[52].

### 5.3.3 Income distribution measures

The previous section showed that 'poverty lines' fail adequately to reflect income distributions[53]. For this purpose, more detailed distributional information is needed. The World Bank, for example, uses quintiles: dividing the population in 5 equal-sized groups ranked by income. Table 4 shows the share of income obtained by each quintile in Brazil, the US and Sweden[54].

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the computation does not account for transactions cost differences and accounting for public goods is weak. As the OECD points out "Per capita volume indices should not be used to rank countries as PPPs are statistical constructs rather than precise measures." Nonetheless, they provide a more accurate reflection than uncorrected income figures.

[50] Note this measure is also based on measured income and should ideally be corrected by imputing the value of non-traded (including public) goods and services.

[51] To some extent tastes are converging.

[52] In contrast to the migration of skilled personnel considered in section 5.2 this induced migration comes at the other end of the education scale. Because destination countries do not value such migrants and because the cultural divide is greater than among professionals (from whatever country), the external societal consequences are also likely to be greater.

[53] This says nothing of wealth or welfare distributions.

[54] This is usually called a Lorenz curve.

**Table 4: Quintile view of income distribution**

| | *Quintile 1 Poorest 20%* | *Quintile 2* | *Quintile 3* | *Quintile 4* | *Quintile 5 Richest 20%* |
|---|---|---|---|---|---|
| Sweden | 9.1 % | 14.5 % | 18.4 % | 23.4 % | 34.5 % |
| US | 5.2 % | 10.5 % | 15.6 % | 22.4 % | 46.6 % |
| Brazil | 2.5 % | 5.7 % | 10.0 % | 18.4 % | 64.4 % |

Figure 3 shows the relation between per capita GNP and the Gini index[55]. They are practically independent, save for the striking fact that no country combines low equality and a high standard of living, suggesting that the wealth of nations requires a minimum level of fair distribution of income[56].

In the most successful countries, the upper quintile has no more than 50% of the country's income. Unfortunately, there is not a one-to-one connection between equality and overall wealth; many poor countries (e.g. Tanzania) have rather similar distributions to rich ones. Despite this, we can draw some preliminary conclusions about possibly successful development paths.

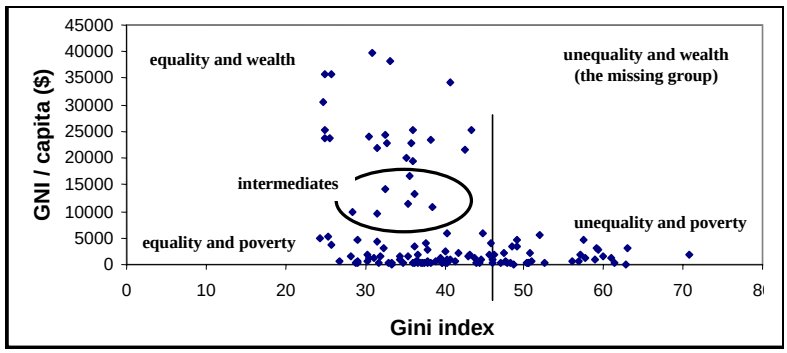


**Figure 3: Cross-country relation between wealth and equity**

In particular, in seems productive to support the lower 4 quintiles of the population and to restrain over-accumulation by the rich[57] - this income is unlikely to be invested in projects whose benefits are broadly spread to the majority of people in their country and may be dissipated in protecting wealth. No country where the richest 20% command more than 50% of income successfully provides for the basic needs of its population.

[55] The Gini coefficient is an increasing measure of inequality: the area between the actual Lorenz curve and the 45$^{o}$ line representing perfect equality.

[56] Radermacher (2003).

[57] In endogenous growth terms, capitalist incentives work best when most members of the population are within a reasonable distance of each other. Incentives operate *at the margin* and large disparities in income (e.g. the cumulative result of incentives correlated with existing wealth) discourage both individual effort and cooperation. This seems consistent with the smaller set of countries for which data on wealth (as opposed to income) are available. It raises particular concerns about the 'tipping' equilibrium tendency of GNKS economies and about the interplay of trade restrictions, IPR protections and other regulatory influences on growth and development.

### 5.3.4 Should there be an upper limit to equality?

The perspective for further development may change if a country is already wealthy. Empirically, too much equality can paralyse wealthy societies, which may lag behind less-equal[58] competitors. While large (and growing) gaps between rich and poor are the main global problem, within rich societies "too much" equality may be counterproductive. Of course, this empirical picture slightly oversimplifies: analytically, *ex ante* (or anticipated) inequality provides incentives, while *ex post* (realised) equity reinforces societal cohesion.

One interpretation of the failure of socialism is that societies where additional work is not rewarded will not develop the overall energy necessary to progress. Socialist economies were not able to compete with capitalist ones because incentives to work were lower. More specifically, behaviour that is rewarded is reinforced (for good or ill). This has four implications.

At the crude level of income comparisons, this strongly suggests that the possibility of changing one's place in the income distribution is an important driver – remove the possibility and the incentive to work disappears, attach movement to selfish (as opposed to cooperative) behaviour and the incentive to share disappears, etc. Therefore, possible *ex post* inequality is essential to progress.

The second implication is dynamic: if yesterday's achievement gives privileged access to today's opportunity, yesterday's winner becomes tomorrow's dominant player. Dominant players need not strive and success will be out of reach of the others – so neither side will put forth effort. Therefore, inequality must not be allowed to 'pile up' – wealth should be kept in circulation.

The third and fourth points look past income distribution. An increasing proportion of income represents (good and bad) returns to risky behaviour. As with equality of income, entrepreneurial activity should bear neither too much nor too little risk, and we should beware of risk 'piling up' in small parts of society. Finally, productive activity[59] in the GNKS involves a mix of individual and collective activities. Property right regimes[60] that reward individuals discourage sharing; regimes that spread benefits too widely encourage free-riding; and winner-takes-all regimes result in an oversupply of effort, most of which is wasted. In sum, equality should not be maximised but should be optimised.

[58] The central issue here is the possibility for individual vertical mobility within the income distribution and its linkage to efforts and skills that advance the general economic interest.
[59] This is particularly true of innovative activity; sharing ideas across disciplinary perspectives contributes one kind of progress, complex work along paradigmatic lines contributes another.
[60] This includes IPR but also rights to the fruits of effort, human capital, corporate profits, co-financing schemes, etc.

### 5.3.5 Internet, wealth and hidden agendas

It is not surprising that worldwide wealth differences correspond to differences in information technology availability. In some countries a majority of the population already uses the Internet; in others the technology is hardly present. The relation between Internet access and overall wealth is shown in Figure 4. There is a large digital divide related to the income divide.

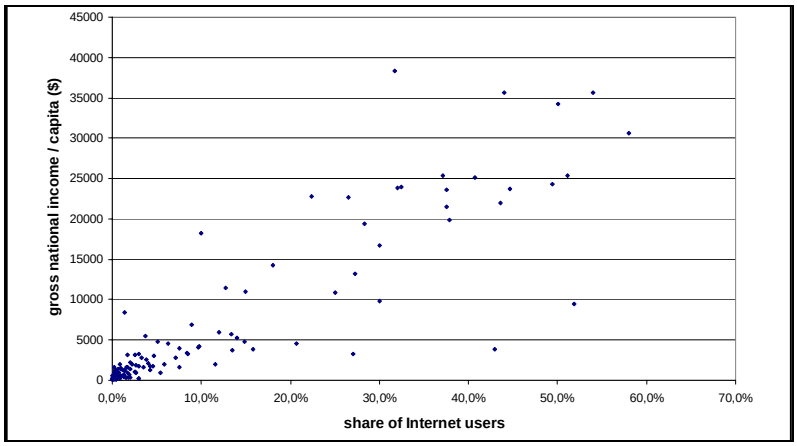


**Figure 4: Gross national income and Internet access**

The figure includes more than 150 countries - most of them (the dots are overlapping) have neither the Internet nor general wealth. In principle, there are many[61] possible causal relationships between Internet access and wealth.

Statistical analysis[62] itself does not answer the question. The Internet has not been around for a sufficiently long time and access is still not routinely measured in appropriate ways. Second, it is not possible to examine whether poor countries that focus on income growth *per se* subsequently have better opportunities to create information societies or whether strategy should to start with massive investment in IT infrastructure to enable later wealth creation. Third, the relationship itself may depend on the *distributions* of both wealth and Internet access[63]. Finally, as both Internet access and economic growth may take many forms, it is appropriate to ask under what conditions positive developments in either sphere contribute to *sustainable* and *equitable progress in the other.* At this stage it is only possible to make some plausibility arguments.

[61] For example, Internet access (I) could cause, or be caused by wealth (W) (or both); some other factor could cause both, there could be no causal relation; or there could be a relationship that depends on some contextual or temporal factor (e.g. culture).
[62] The standard (Granger) test is to correlate each variable with lagged values of the other variable. If I is correlated with $W_{-1}$ but not *vice versa* then W causes I and so on.
[63] Cave (2003b) shows that the distribution of human capital outperforms either aggregate human capital or income distribution as a predictor of growth.

Wealth causes the development of Internet access. Historically, most countries with high current levels of Internet use today were wealthy 20 years ago. Moreover, within countries, digital and financial divides are correlated. Rates of Internet access differ in predictable ways with ethnicity, gender and employment – though this does not imply a straightforward causal relationship between wealth and Internet access. The lower Internet access of disadvantaged groups is correlated with an educational deficit, which might itself explain lower rates of Internet access. Wealth may be necessary but not sufficient for an information society.

**Empirically, low costs of Internet access are necessary but not sufficient to induce high levels of access.**

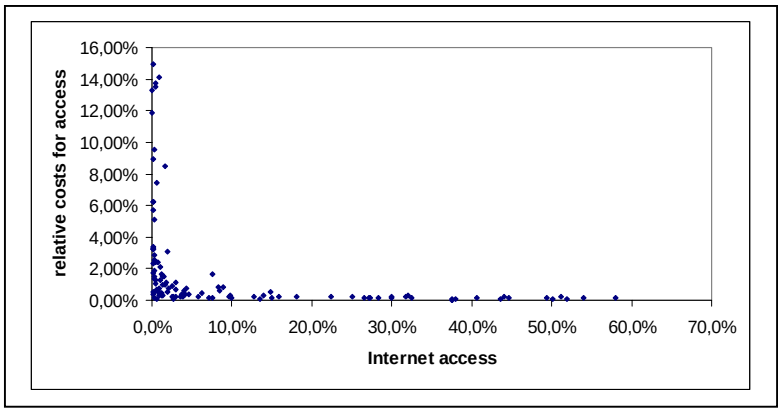


**Figure 5: Relative costs and Internet access**

Internet access causes income growth. This is the position of many hardware and software providers. In recent years, despite the 'bursting of the dotcom bubble[64]', they have successfully argued that developing countries can catch up only if provided with the opportunities of the information age. "ICT for development" was the motto of innumerable non-profit initiatives delivering Internet to the poor. However, help is not always as altruistic as at first appears[65]. Western countries use development assistance to support their own industries. In any event, there is still no convincing evidence that provision of Internet access necessarily and substantially improves the situation of the poor. Besides, we had similar discussions around the deployment of telephony and even television...

[64] It is not yet clear what the implications of the widely publicised collapse of high-tech stock prices mean for market behaviour or the 'real' functioning of the economy. Nonetheless, a watershed has been passed, and revised expectations have certainly changed the perception that IST progress is *sufficient* for rapid and sustained growth.

[65] Of course, the fact that businesses or the West profit by their activities is precisely the same as the notion that economic incentives spur growth – we are trying to harness the engine of industry to societal good (international development or national economic growth). The deeper question concerns the geometry of the harness – whether divergent motives distort or inhibit underlying development mechanisms. Analytically, these mechanisms determine the reciprocal influence of wealth and Internet access *on each other*, and the sustainability, ecological impact and equity consequences depend on how these mechanisms are mobilised, but not *necessarily* on why.

Wealth and Internet call for each other. There is reasonable evidence that the information society cannot develop without financial resources; it is equally obvious that information technology helps significantly to support modern economic and administrative processes. One of the most important innovations is business-to business electronic commerce, which reduces transaction costs. The recognition of weak mutual causality between wealth and the development of the information society leads to a moderate and very specific role for IT provision in development programmes.

This argument does not take direct account of fair division and efficiency issues. A more detailed account would include the influence of societal mechanisms on equality of access. Access to wealth (command over private goods and services) influences demand for the Internet and the (public and private) goods and services available through it. Consumer wealth also provides investment capital that funds Internet provision. Changes in the distribution of *access to wealth* change the influence of individual preferences and the allocation of wealth among savings, consumption, investment and even taxes. Conversely, Internet access provides welfare-enhancing services including – but certainly not limited to – opportunities to purchase an ever-expanding range of goods and services at competitive prices – thus enhancing the *welfare content of wealth*. Thus patterns of access influence both the nature of the Internet[66] and its impact on wealth creation and distribution. As there is evidence of two-way causality, policy should be explicitly co-evolutionary: working with economic and IST tools and stakeholders, basing policy on signposts indicating which group is driving the current phase and looking beyond measured growth and access to the details that determine sustainability, equity and efficiency. This may mean correcting tipping tendencies or shoring up sustainable and economically productive Internet use and access (e.g. by building appropriate levels of trust, suppressing spam, etc.). This in turn requires joining up policies relating to competition, standards, R&D, etc. The other main point about mutual causation is that it is necessary to get below the aggregates to understand what's really going on attain meaningful objectives.

Internet access and equality. Section 5.3.3 showed that countries with too much inequality are not among the richer ones. Whatever the causal link(s), it is not surprising that the same is true of equality and Internet access. Countries with low equality have low levels of Internet use. The majority of the population cannot afford hard- and software and government lacks resources to support universal public access. The relationship is less stark (compare with Figure 3) in part because Internet access attracts more public and industrial support as a route to economic growth than redistribution does.

[66] E.g. do its offering represent value for money, are the content and forms of societal interaction beneficial, etc.

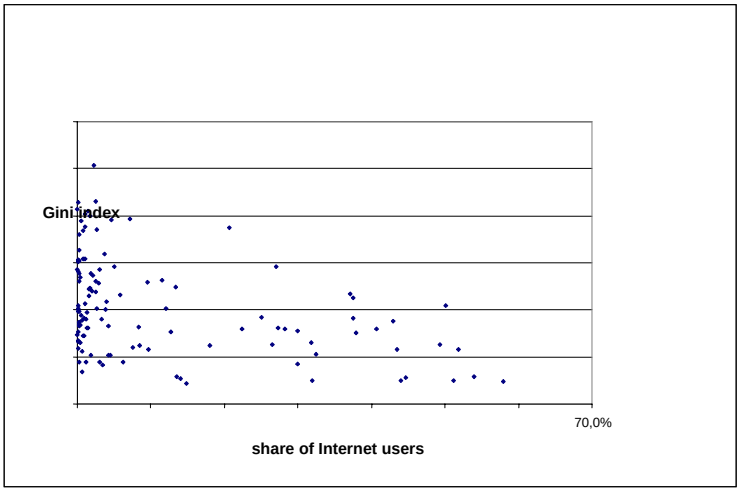


**Figure 6: Equality and Internet access**

5.3.6 Summary

TERRA research is consistent with findings in the literature on the relation between income inequality and growth. Taken at face value, data indicate at best a U-shaped ('Kuznets curve') relationship, suggesting that a balance of growth rates and levels of equality may be preferable to extremes of either. However, the real 'punch' of this research concerns the underlying relationships, the specific impact of the GNKS, the sustainability implications of possible trajectories and the international implications.

In terms of the underlying relationships, econometric analysis shows that, while the relation between *income* inequality and growth is decidedly not monotonic, greater inequality in *human capital* is always and robustly associated with lower growth. A second finding is that income inequality has complex and location-dependent connections to welfare, depending on, for instance, the degree to which the means of life are publicly provided (or subsidised), the security and resilience of quality of life, and the degree to which individuals, households and communities judge themselves by absolute standards or by comparison with local or global reference groups. Clearly, the GNKS, by changing incomes and the dynamics of careers and economic sectors, and by making people aware of the lot of others in remote parts of the world, profoundly affects these relationships.

A second aspect of the GNKS is that inequality of *access* to the opportunities an knowledge it affords may exacerbate existing societal and other divisions, or may protect valuable cultural and societal diversity. It is not obvious *a priori* that market forces will necessarily lead to a good combination of these possibilities – more specifically, that people will be able to choose the degree and nature of their involvement with the GNKS and, through it, with each

other. The basics of informed choice, in the form of partnership, communication and the provision of GNKS infrastructures, skills and services on an equitable and affordable basis would seem to be a s*ine qua non* of this development. Due to a combination of cost, political educational and other factors, at present the distribution of access to the GNKS is (at least on a world-wide scale) even less equitable than the distribution of income. Moreover, at (both) extremes of the income distribution the potential significance of the GNKS is not well-appreciated, and thus short-termism can threaten long-term sustainability.

Finally, as the thematic scenario analysis shows, the sustainability of economic development depends not only on the recognition of these systemic factors but also on the nature of governance. The economic engine is driven by informed and appropriately constrained choice; societal, governmental and business decision making require the same lack of undue compulsion and sensitivity to externalities. This analysis has led some members of the project to propose bold new partnership initiatives in which countries with different immediate objectives (e.g. economic development, market access, adherence to standards) effectively cooperate or trade with one another using the engagement of the GNKS to permit negotiation about fundamentals that cannot be wholly captured in property rights.

## 5.4 TERRA's Work on GNKS

TERRA worked in several directions around the main line outlined above (running from economy to society by way of the Internet). TERRA also undertook additional work on the contribution and perspectives of different types of actors (e.g. individuals acting as consumers, voters and members of civil society organisations), the structural aspects of the mechanisms underlying the economic and societal impact of the GNKS, the two-way linkages between human capital and equity and the issue of security as a specific aspect of sustainability. This additional work is summarised below. At a deeper level, these contributions concern the governance of the GNKS. While TERRA has no general theory to propose, section 5.4.5 links this work to some general frameworks for the GNKS.

### 5.4.1 Individuals

In the prevalent view of economists and political scientists, individual choices drive the functioning of government (through voter power), private industry (through consumer sovereignty) and civil society (through participation). These choices in turn are mediated by societal values. The neoclassical approach to (especially economic) institutions is based on individual preferences and instrumental (see Sec 5.4.5) rationality. It tends to take preferences as fixed and thus does not address the correlation among preferences or the processes by which they change. This approach is adequate for analysing narrow phenomena (e.g. consumption behaviour or

choice of production technologies as means to selfish economic ends) but fails completely to address crosscutting issues such as disruptive technologies, non-selfish preferences and the fact that collective action cannot be understood simply by adding up individual behaviour. Some values that (should) underlie preferences have their strongest impact on individual action, while others are either difficult to apply to individual decisions, too costly to undertake on an individual basis or not regarded as 'solid' unless endorsed by a sufficient number of community members[67].

Responses to global problems may thus seek specific channels as a result of perceived failure or irrelevance of other channels[68] and because the route from values to actions runs through those channels. This explains, in part, why discontent with the operation of the individualistic global capitalist system finds expression through (more or less) collectivist civil society channels[69]. It also implies that foresight about the evolution of the GNKS must consider changes in value systems and their actualisation. As mentioned in Section 4.3, TERRA tracks changes in values as assessed by the World Values Survey[70] and incorporated into the modelling system. Some values and mechanisms for value change are directly linked to exogenous societal characteristics such as age, so some aspects of the future can be predicted on the basis of the demographic transition. Others are tied to the use of technologies that change the way people exchange and discuss ideas[71], so the spread of e.g. collaborative technologies to facilitate joint action affects both the transformation of values[72] and the route from values to action[73].

### 5.4.2 Infrastructure of the GNKS

Two features differentiating the GNKS were the subject of particular focus during the project; networking and IPR. Theoretical[74] and computer[75] modelling were applied to study the evolution of networks and the evolution of behaviour within networks. In the extended problem considered in this section (policy responses to changing patterns of demand for and supply of skilled labour and management of the distributional consequences), the structural analysis indicates that: networked societies are likely to have asymmetric (power-law) distributions (of wealth, power, access, etc.); starting geometry and changes to the rules of network formation (specifically, the influence of indirect connections and weak links) have a large impact on the shape and equity characteristics of networks. Evolution favours risk-

[67] Schauer (2002).
[68] Soete and Weehuizen (2003).
[69] Castells *op. cit.*
[70] See http://www.worldvaluessurvey.org/
[71] This is linked to Habermas' concept of communicative ethics – see Sec 5.4.5.
[72] Soete and Weehuizen (2003).
[73] van Audenhove (2002)
[74] Cave (2003c)
[75] Tesch (2003) listed in Annex V

dominance[76] over efficiency; homogeneity (conventions or norms) tends to prevail in fully connected networks; and stable diversity is possible only if the network geometry (who is connected to whom) is 'right.' Labour markets can 'get stuck' in inefficient situations from which neither supply-side nor demand-side policies can free them, but a judicious combination of both will help evolution to resolve the problem. A second implication is that policies that operate directly on the pattern of connections can resolve problems that cannot be addressed in other ways.

The second infrastructural characteristic addressed was IPR. The GNKS works on information and requires innovation for its development. These exchanges and activities take place in various institutional settings with different norms of behaviour. Traditional socio-economic analysis has focused on a private sector domain motivated by economic or financial concerns and an academic domain motivated by curiosity. Incentives for creation and exchange of information were provided by systems of property rights (copyright, patent, authorship, etc.) provided by different types of authority (international, national and peer-group, resp.) establishing different limits of use and bundles of rights (e.g. fair use, compulsory licensing, citation rights) and subject to different transfer arrangements. Many rights were defined at the individual level. The advance of ISTs has changed the nature and production of knowledge, and old rights regimes are no longer appropriate. This distorts knowledge creation and sharing[77] and leads to emergence of new channels for bypassing the protections and access transactions supplied by the existing rights systems (e.g. copy-protection and file sharing). Attempts to extend existing systems to new forms of information (e.g. databases) raise specific dangers. Finally, the valorisation of knowledge previously regarded as a commons (e.g. traditional knowledge) has led to equity problems. Various papers[78] written during the project specifically address these issues and provide at the same time specific policy prescriptions and pointers as to how to incorporate infrastructural aspects into the scenarios and models.

### 5.4.3 Two-way linkages

Linkages between equity and growth are rooted in the distributional proposition. TERRA has investigated various aspects of these linkages and developed insights into the way policy in one sphere affects the other. The main avenues of investigation are endogenous growth and wage asymmetry, network effects and inequality and human capital inequality.

There is much evidence of widening inequality in developed countries between skill levels in market-dominated economies, within skill levels and

[76] The relevant criteria are: equilibrium (no individual wishes to change unilaterally); efficiency (no alternative arrangement could be reached by unanimous consent) and risk-dominance (no other behaviour would be as robust against shocks to others' behaviour).
[77] See Heal and David (2003) for a discussion of the impact on 'open science.'
[78] E.g. Cave (2003c), Tesch and Descamps (2003)

between employed and long-term unemployed in social market economies. There are three conventional explanations for at least the first of these:

- Trade liberalisation[79] – The 'North' trades knowledge-intensive goods for less knowledge-intensive goods from the 'South'
- Deunionisation[80] – Unions bring wage compression, so waning unions should spread wages; and
- Skill-biased technological change[81] (SBTC)

One possibility is that increased supplies of educated workers facilitate SBTC –skill premia and prices of high-skill products would fall, reducing per-unit returns to improving them while at the same time increasing their relative production. If the latter effect dominates, skill premia will rise in the medium term. A further effect is to increase rate of innovation. However, this does not explain the *lack of polarisation* during previous episodes of increased educated labour supply (e.g. 1900-1920), the post-1970 productivity slowdown or the rise in residual (net of skill differences) inequality.

These stories treat skill as part of human capital: factor demand curves *always* slope down, so educated workers' relative productivity must have increased. In this story, GDP *growth* requires human capital *growth*. By contrast, Schumpeterian theory directs attention to innovation, learning-by-doing, absorption and the diffusion of technology, so GDP *growth* is driven by human capital *stocks*[82]. The key differentiation separates specific technologies from *general-purpose technologies*[83], which trigger secondary innovation as they diffuse. This accounts for the empirical facts of rising skill premia and slowing overall productivity (due to the costs of adopting, adapting). Moreover, the time-path fits a logistic spread pattern due to e.g. network effects (lock in) and learning. Residual (within-skill) inequality can then be attributed to unobserved flexibility and the winner-takes-all tournament effects particularly pronounced in GNKS labour markets.

The emergence and stability of inequality in networked environments has also been studied both within and outside the project[84]. Inequality can be stable, depending on how the fruits of linkage are divided up and the network's starting geometry. Closely related work on random networks[85] identifies a

[79] This is not supported by evidence on trade size, relative prices, labour shifts, or changes in 'South.'
[80] But US (UK) deunionisation began before (resp. after) wage spread.
[81] This is supported by labour, productivity shift data, but why did SBTC accelerate after late 70's? Possibly capital-embodied, but overall productivity grew slower after 1975 than before.
[82] Aghion (2002), Howitt (2000).
[83] Examples: steam, dynamos, lasers, ICT.
[84] Bardhan, Bowles and Gintis (1999), McKenzie and Rapoport (2003), Calvo-Armengol, A and M. Jackson (2002).
[85] E.g. Tesch (2003) and references therein.

particularly persistent form of inequality arising from growth: scale-free (power law) distributions. This suggests policy attention to conditions that shape the evolution of inequality rather than to *ad hoc* redistribution to address the inequality itself. This is wholly consistent with the policy advice in sections 5.2 and 5.3 above, which highlight equality of access to human capital and co-financing of egalitarianising growth. A further implication is that policies that reduce the risk associated with movements toward equality (or to reduce the size and persistence of incentive rewards through e.g. IPR reform) can work together with evolutionary forces to resolve persistent inequality without jeopardising progress.

TERRA#s more empirical work in this area is based on the well-known Barro-Lee human capital data set[86]. The mechanisms linking income inequality to growth are split between demand and supply and between final consumption and labour markets. Thus it is not surprising that estimated relationships are highly sensitive to new observations or countries. If standard inequality approaches (Gini coefficients, quintiles) are applied instead to data on the distribution of human capital the results in growth equations are more intuitive (inequality always depresses growth) and robust. While the *ex ante* promise of inequality motivates effort, its *ex post* impact (especially when past winners have differential access to education) deadens incentives at both ends of the distribution. Policy that improves equality of access to human capital opportunities favours growth within and among nations.

### 5.4.4 Security

The world has been spared world wars in recent decades, but conflict and violence have not diminished. In particular, there has been a rise in strife within states. Global integration seems to be counterbalanced by equally strong fragmentation. Ethnic groups reassert their identities[87] in ways that sometimes lead to large-scale suffering, gross abuses of human rights and massive refugee problems, sometimes requiring external intervention. These internal conflicts highlight the vulnerability of minorities. The focus of new security concerns is not so much other states as sub national/asymmetric conflict, criminality and instability.

From Spengler to Fukuyama, rivalry has been seen as inherent among sovereign states. In the past, security was a tragic commons: states' efforts to increase *their own* security by military capabilities, alliances and protectionism invariably threatened other states. In the 21st century, the world has become too small and too crowded, its people too intermingled and too interdependent to sustain the distinction between 'our' security and 'theirs.' Hardt and Negri and other post-modern political epistemologists see a

[86] Barro and Lee (2000)

[87] As the world globalises, traditional 'economies of scale' that caused different peoples to 'band together' weaken and a finer granularity re-emerges.

(potentially) positive scenario in which the dichotomy between 'us' and 'them' becomes an internalised source of diversity below the level at which war breaks out.

Crime also threatens security. Globalisation has been used primarily to describe aspects of world economic activity. But other less benign activities, including terrorism and traffic in drugs and nuclear materials, have been globalised. The borderless world offers more scope for international criminals[88].

Disease is globalising as well. Global cooperation has eradicated smallpox, and eliminated TB and cholera from most places; but now the world struggles to prevent their resurgence and to control the global spread of AIDS.

In this world, *social security* is no longer the crown on economic development, but a burden that hampers flexibility and innovation, perverts incentives, decreases labour participation and increases the tax burden. In other words: social security is increasingly seen as a competitive disadvantage and a source of conflict among socio-economic classes, generations and any other groups differing in contribution to or reliance on social security. To what extent that view is justified is an important question. Social security systems have traditionally provided institutionalised solidarity, fostering trust and creating social capital, which is of paramount importance in individualistic western societies whose complex economies rely on countless smooth transactions among more or less anonymous participants. If they no longer fulfil this function, some other mechanism must be sought and the transition and acceptance managed carefully.

As has become clear, all the dimensions of security are important to societal well-being. *Collective security,* as envisaged in the UN Charter, is based on an us/them dichotomy: members of a particular group renounce destructive activities (e.g. the use of force or protectionism) among themselves while pledging to defend any member attacked by external forces. *Comprehensive security,* on the other hand, reaches out to include all groups in an overarching collective via co-operation, confidence-building, transparency, gradual disarmament, conversion, demobilisation, and demilitarisation. A recent people-centred approach - *human security* - is concerned not so much with groups and their wealth and military security as with basic human dignity. The *Human Development Reports* embrace a concept of human security that includes safety from chronic threats (hunger, disease, and repression) and sudden and harmful disruptions to daily life. This broadening

[88] In other words, it is not obvious that solutions make the transition to global scale more effectively than problems do, or that the localised rebounds are positive on balance.

shows that the risks have changed. The new dangers come not from outside but from within.

The sociologist Anthony Giddens uses the term 'manufactured risks' for events (e.g. unemployment and pollution) caused by human action that nevertheless seem as inevitable and unavoidable as natural phenomena like a earthquakes or floods. The global management of such manufactured risks has met with at best limited success and impact.

New information and communications technologies, in addition to driving economic globalisation and social transformation, have also transformed the spread of information with important consequences for national and global governance. Media exposure to foreign cultures and life-styles can be both stimulating and destabilizing; it can inspire appreciation, envy and even fear. Concerns over the dominance of transnational media, cultural homogenisation and damage to indigenous culture and fears that the replacement of cultural expression by cultural production will undermine cultural sustainability are not limited to non-Western countries.

Sulak Savaraksa, a prominent Buddhist thinker and activist, expressed his deep concern on seeing how Buddhist values of spirituality, harmony and friendliness have been completely overwhelmed by market capitalism in Thailand during his lifetime[89]. He saw people captured by a feverish striving for material wealth that did not necessarily lead to better quality of life or more happiness. The capitalist system is opposed to Buddhist virtues of sobriety and overcoming of self-interest. He sees this 'consumerism' as a pseudo-religion, and poses the question of the trade-off between material gain and spiritual loss among the poor in Thailand. Similar concerns seem to inform 'Islamic economics', which aims to restructure economic thought and practice on the basis of fundamental Islamic teachings. Medieval Christianity forbade interest on loans[90] and condemned striving for worldly possessions. As Max Weber (1930) pointed out, the Christian reformation exchanged this for new virtues of hard work and accumulation.

In essence, we can analyse this from the game-theoretic *mechanism design* perspective. Institutions and systems of values are valued for their functions – whether they help us to live together and lead fulfilling lives – rather than for their intrinsic 'rightness[91]'' But human mechanisms change humanity and have their own dynamics – so we should not be surprised if they begin to undermine the purposes for which we thought we used them. In particular capitalism is under continuous attack, not only for practical reasons (e.g.

[89] Savaraksa (1992)
[90] This mirrors the us/them distinction of collective security concept, since loans – at interest – were sought from Jews.
[91] 'By their fruits you will know them' Matthew 7:15-18.

inequality, environmental damage) but also because many doubt its underlying assumptions of the system. Welfare does not necessarily increase well-being, and can even decrease it[92]. Without the religious justification of hard work and accumulation the low correlation between material welfare and happiness has serious psychological implications[93].

Democratisation (in various forms) of the nation state is another global phenomenon that does not always survive aggregation. Certainly there is little evidence that democracy is assured at the trans- or supranational level. A bunch of democracies together do not automatically form a (meta-) democracy – indeed, it may be harder for them to engage the efforts of an informed and concerned citizenry which is in some ways the end that we sought through the mechanism of democracy.

Rather than conceiving democracy as located in a particular kind of inclusive sovereign unit, and attempting to scale it up to a global level, Dahl and Tufte (1973) argue we must learn to conceive of a democracy spreading through a set of interrelated political systems. The central problem is no longer to find suitable rules to apply within a (larger) sovereign unit, but rather to find suitable rules to apply among various units, none of which is sovereign.

Loyalty to a group depends upon one's identification with the group. One can feel 'American,' 'French' or 'Japanese' and be loyal to the country no matter how much one disagrees with government policies. To leave a group because of disagreement with its formal policies is painful, emotionally costly and even disempowering. Loyalty does not normally mean reluctance to leave a collectivity, but rather positive commitment to further its welfare by working for it, fighting for it, changing it for the better (Barry 1974). Loyalty depends on the extent to which one identifies with a group and the extent of personal investment. Identification in turn involves experiencing the group as a constituent part of the self. You may find it hard to leave the house in which you were born, even if it is falling apart and there are much better houses available. The company you worked for the last 20 years, the nation of which you are part - all these things are important part of your self-definition, and giving them up means losing part of your identity.

These legacy aspects of identity represent ‘past voice’. People tend to attach to the relationships, companies countries, etc. they have worked for, on, at. A fight often strengthens a personal relationship, an employee can give voice to his ideas about the product or service of his company, and a citizen literally

[92] (Scitovsky (1976), Easterlin (1974), Inglehart (1995).

[93] Clearly, money makes a huge difference in poor countries and for poor people. Up to a certain income, material gain is strongly correlated with increased well-being, but above that the correlation drops and happiness is more correlated with such non-economic factors as the amount and quality of social relations, and even with certain genes.

has a 'vote' in his country. The motivations for such actions are only partially instrumental (e.g. voting to influence the outcome of an election) – they are also expressive (e.g. of support for a position or for the institution of democracy) and self-affirming (e.g. to remind oneself of one's identity and thereby renew it. Two aspects of the GNKS challenge both the strength and the utility of identity. First, the globalisation of interaction means that the network of relationships more tenuous, remote and complex, which reduces the degree of investment/ Second, the relationships become more function-specific – we tend to know many more people in much narrower contexts, so that our concept of identity becomes fragmented. This leads to the rapid depreciation of social capital as noted by Puttnam and others, and to a more labile and less sustainable concept of identity that makes effective collective action harder to conceive and implement. The solutions are to be found in an understanding of the concepts of engagement as well as inclusion and in increasing *voice,* which in turn requires enhanced levels of societal trust. Otherwise, belonging everywhere, we may belong nowhere, and 'vote with our feet' sooner rather than later.

At a global scale, there are *no externalities*[94] - - save one: externalities towards the future. Global governance offers *no exit option,* therefore a concerted effort to preserve and adapt voice and loyalty is needed: globalisation disturbs existing fine-tuned institutional balances in the framework of the nation-state. A new division of labour between state, market and community is emerging and many present developments can be understood in that light.

### 5.4.5 Governance

These results do not necessarily reflect the underlying causal mechanisms or the ways in which they are changing. It is fairly evident that observed results stem from the interplay of various communities of interest, each of which is further subdivided. These considerations are particularly relevant to issues involving equity, as it is in this area that the developments identified in the scenario analysis pose the greatest challenge to governance structure and function precisely because they change the perceived relation of each to all and thus the trust participants in the GNKS place in each other and their governance institutions. The first of these is bound up with identity and the second with social institutions as causes and effects of social evolution.

The impact of the GNKS is four-fold:

- It changes the way 'governance spheres' make decisions
- It changes the implementation and systemic impact of those decisions
- It changes the extent of and motivation behind individual engagement and

[94] Save for storing nuclear waste on the moon, which merely plays semantics with the globe.

participation, and

- It changes the actual and ideal allocations of competency among the various layers and spheres of governance.

The lengthy treatment of these issues in the governance literature goes some distance beyond the scope of TERRA. Nonetheless, some consideration of these matters is needed to put these results into perspective and to guide TERRA's contribution to governance debates. The following paragraphs (too) briefly comment on these developments.

Societal decisions are made in overlapping spheres with specific powers, competencies, objectives, organisation and norms. A simplified view distinguishes: public (Administration), private (Business) and societal (Civil, comprising customers, consumers, citizens, constituents, etc.). Each has different (but interacting) macro, meso and micro levels. Decisions are made and implemented via specific transactions (including exchange of information) within and among them. Governance arrangements thus combine the division of responsibility among the domains, the structure of connections and behaviour. Figure 7 shows the alignment of domains, transactions and 'layered' governance.

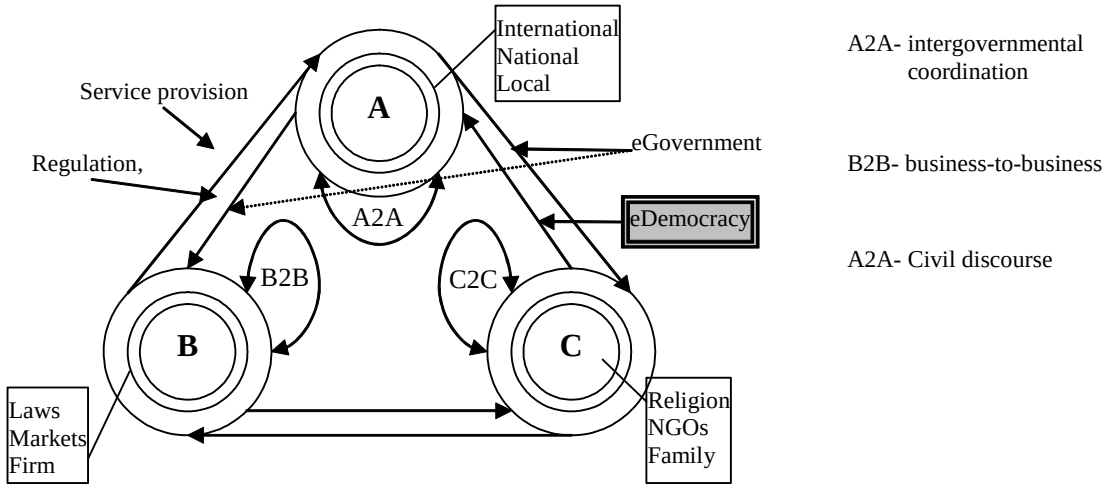


**Figure 7: interlocking, networked governance**

From the TERRA modelling standpoint, each layer's governance structure is networked – the behaviour of the system and the influence of ISTs can usefully be understood through an appreciation of network effects. Some are very simple, reflecting group membership or identity, while others involve more complex relationships[95]. The network perspective runs through the analysis: the identification of issues and the formation of constituencies around them depend on discourse and influence flows through networks of

95 Some network effects follow indirect links while others depend in subtle ways on finer details of who is linked to whom –all societal networks have rich structures, with but indirect, weak or absent connections.

individual stakeholders, networks of institutions (for addressing issues) and semantic webs linking aspects of an issue. Participation is link formation – the process by which networks evolve – and its societal significance derives from behaviour of individuals in the context provided by their connections. Finally, trust itself is a 'networked public good' both because it draws on relationships and because the very act of participation (or joining a network) involves trust. The analysis of networks draws on roots in many disciplines. For present purposes, it suffices to indicate a few findings from each.

**Table 5: Key features of approaches to network analysis**

| Discipline (network) | Feature(s) |
|---|---|
| Physical sciences (random) | Clustering (power-law distribution of links)[96]<br>Small worlds (groups more likely to be linked to each other than to 'outsiders')[97] |
| Economics (complements) | 'Tipping' (winner-takes-all)[98]<br>Standardisation (lock in others by framing the issue)[99] |
| Game theory (strategic) | Stability of 'risk-dominant' conventions[100]<br>Tension between stability and efficiency[101]<br>Communication costs, structure influence behaviour[102] |
| Epistemology (semantic) | Clustering (powerful ideas draw others closer)[103]<br>Mimetic evolution (variation, selection, heredity)[104] |

For the analysis of issues relating to equity and growth, the key ways this analysis is applied are:

- Perceptions of equity – and especially changes in relative equity – are closely tied to changes in trust
- Participation is the key to having the external impacts of changing equity internalised in societal decision making
- Attitudes towards poverty and other divides reflect societal conventions and are subject to evolution – which in turn reflects and determines the structure, strength and resilience of societal network interactions
- As a result, the effectiveness of different spheres of governance and the degree to which underlying human problems can or should be tackled by inward- or outward-looking policies by e.g. European governments cannot be considered in isolation but must take direct account of networking.

[96] Barabási, 2001
[97] Watts 1999
[98] Katz and Shapiro 1994
[99] Economides, 1996
[100] Kandori, *et. al.*, 1993, Young, 1993
[101] Dutta and Jackson, 2000, Jackson, 2003.
[102] Jackson and Watts, 2002
[103] Berners-Lee, *et. al.* 2001
[104] Blackmore, 2000.

In terms of the four impacts of the GNKS identified above, this leads to the following specifics. First, more rapid and 'broader' communication may increase or decrease trust; in particular, neither the normative superiority nor the evolutionary triumph of representative (or direct) democracy coupled with competitive capitalism can be taken for granted. Second, compliance with governance depends on the ability of individuals to bypass or opt out of these mechanisms. The GNKS changes both perceived and real costs and benefits of 'switching' – this is particularly important at the international level, where compliance can no longer be taken for granted. Global governance may require a rebalancing of local and collective action. Third, monitoring and enforcement become increasingly costly as the GNKS spreads[105]the effectiveness of governance depends ultimately on its legitimacy and thus on individual identification, trust and participation. As data on inequality increase, so to does their political importance and the 'rebound' impact of those who worry about the adequacy of such measures to capture the human aspects of welfare. It should also be pointed out that in some sense trust and information are mutually opposed: those who can observe each other do not need to trust each other and may be inclined to limit their (network) interactions to the 'safe zone' making systemic issues that much harder to deal with. Finally, as the spread of the GNKS changes the relative ability of governments, private industry and civil society to perform various societal functions, there is a real possibility that the boundaries between, say, public and private goods or between public and private spaces will change. Technology is particularly important in this, as it often embeds concepts of relationships. For instance, business-derived systems may embed supplier-client relationships that may not be wholly adequate for eGovernment or civil society uses of these systems.

These formal representations do not fully explain either societal evolution or the impact of the GNKS, though they do provide a context within which considerations of eGovernance can be considered and the sustainability of responses to emergent divides analysed. At a deeper level, philosophers and sociologists have produced rich and compelling descriptions of the underlying co-evolution of people and their societies, which should form the framework for a consideration of the ethical and structural implications of the phenomena identified here.

For instance, Habermas[106] has developed a comprehensive theory of societal evolution and modernisation based on differences between communicative and strategic/instrumental rationality. Habermas sees social humanisation and

[105] While it may be technically possible to collect data on individual wealth, criminal activity or even political preference, the burden of making sense of this wealth of data increases – not least for individual voters, businessmen, citizens, customers and activists. At the same time, indirect threats to privacy and security often rise rather than fall with information collection and use.

[106] See McCarthy, 1971, and Braaten, 1991).

democratisation as institutionalisations of innately human communicative rationality. This rationality, which reflects social evolution is suppressed in modern society by the encroachment of instrumental rationality on the major spheres of social life. A more specifically GNKS approach is represented by Castells[107], concept of the "network Society." This has its roots in a wide range of disruptive causes[108], and has as its main characteristics: a global information economy; networked enterprises; a transformation of work and employment; social polarisation; a closer connection between political governance and media; and structural reorientations (timeless time and the space of flows). The fundamental insight from the TERRA perspective is precisely the ceaseless attempt to escape from societal constraints and the attendant continuing evolution of values, institutions and identity. One consequence of this evolution is that it is no longer reasonable to regard institutional evolution as 'slow' and individual evolution as 'fast' – rather, the network society can only self-regulate through shared cultural codes (e.g. understanding of poverty) and a recognition that the real struggle is to change the rules of the game. This explains the emergence of identity-based social movements, which respond to the suppression of communicative rationality of which Habermas warned by trying to emphasise direct experience, meaning and the value of life over instrumentalism, functionality and network values.

[107] Castells, 1996, 1997, 1998, 2001.

[108] e.g. the IT revolution (including bioscience), the collapse of communism and the end of the Cold War, the restructuring and globalisation of capitalism, the resurgence and/or spread of nationalism, feminism, environmentalism, communalism (including religious fundamentalism) and threats to the nation-state, democratic legitimacy, and the global rule of law.

# Section 6

## Examples of Policy Issues Relating to Man's Environment

# 6 Examples of Policy Issues Relating to Man's Environment

## 6.1 Introduction

This section covers work accomplished in the Information Age Sustainability thematic analysis. As before, the work is illustrated by following a sample problem: human interaction with the environment and in particular the linkage of economic development and environmental sustainability. This starts with a top-level view of sustainability based on global aggregate data and the dominant relations that must exist among them. This leads to fore- and back-cast scenarios and policy guidance in terms of the directions in which these high-level indicators *must* evolve if policy objectives are to be achieved, leading in turn to identification of a set of problems and to setting the common boundaries of an overall policy framework for application both within and among nations. To go further, it is necessary to ask *why* we see the behaviour that we observe, *what* is the nature of its evolution (as a system with internal and external feedback loops and based on imperfectly rational human choices) and *how* (at a precise level) can interventions be designed to assist that evolution.

It is worth recalling that the policy issues considered in Section 5 flowed from local, short-term concerns to their global medium-term spillovers, while those considered in Section 6 start with the global medium-to-long-term sustainability problem and work back to a more explicitly dynamic perspective. This is in line with the position noted in Section 5 that distributional issues tended to be associated with sectoral and tactical viewpoints and large aggregates with global – strategic viewpoints.

The discussion considers two main issues:

- Environmental impacts of economic activity (use of non-renewable and common resources)
- Sustainability of the GNKS - this integrative theme goes beyond environmental impact in 3 ways:
    - it takes a longer time perspective (and thus considers endogenous growth and induced technological change)
    - it looks at the economic, societal etc. domains
    - it considers resilience as well

## 6.2 TERRA's Work on Global Environmental Issues

### 6.2.1 Development and the environment

Today it does not seem as likely as it did 30 years ago that shortage of mineral resources or fossil fuels will be the major factors limiting human welfare for the coming decades.

In industrialized countries per capita economic growth contributes more than population growth to environmental stress. In developing countries the opposite is true. The joint negative environmental impact of these two factors exceeds the positive contribution of technological development.

Thus it can be said with great certainty that appropriate technological development and ethical socio-economic conduct are the most important factors missing from our quest for a sustainable future.

The new information and communication technologies (ICTs) are strongly linked to rapid development in all areas of science and the humanities, enable rapid knowledge distribution and application and lay the groundwork for endogenous societal transformation and economic growth[109]. In principle, they offer the potential for economic growth and more equitable distributions of wealth and welfare without increased environmental stress.

Periods of transition last for decades. At present we are moving from an industrial society based on manufacturing to one based on services (Figure 2.1). This period of transition is called the Information Society because the information richness of emergent goods and services is complemented by increased construction of and reliance on ICT infrastructures. In the longer perspective of modernity beginning with the Enlightenment, the Information Society forms one part of a late-modern transition to post-modernity.

[109] See e.g. Kaivo-oja, Ahokas, Malaska and Luukkanen (2002), Ahokas and Kaivo-oja (2003).

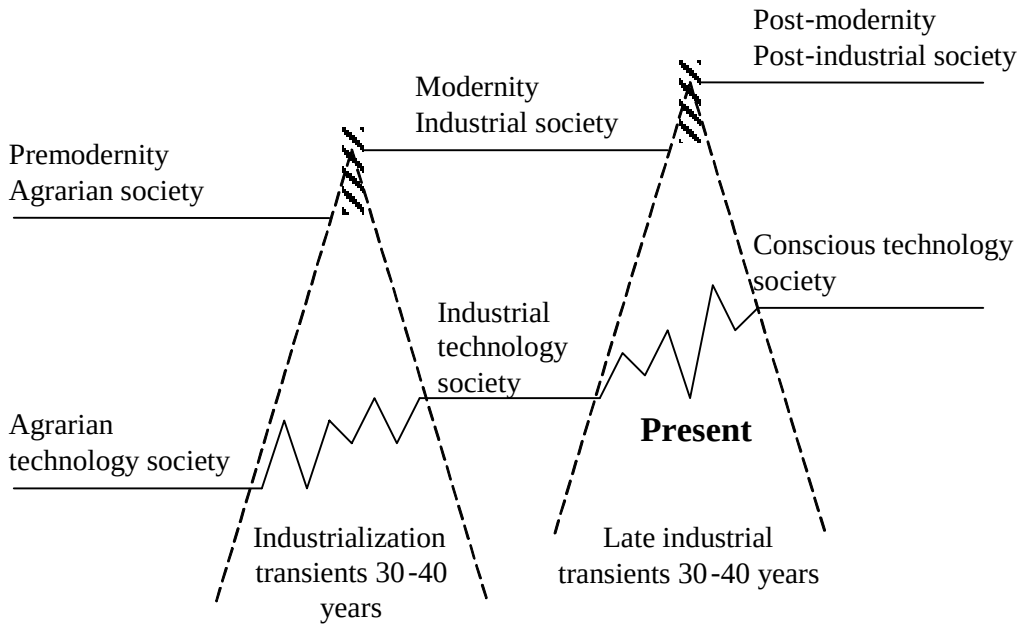


**Figure 8: Two different societal change perspectives[110]: step by step continuity or a transition period between development stages**

Numerous statistical studies during the past four decades have established the dependence of most low-income countries on extractive industries: agriculture and primary products. As today's developed countries progressed[111], manufacturing contributed more to gross national product (GNP). At this middle income or newly industrialising country (NIC) stage, natural resource use intensity increased to support emergent urban industrial centres. Due to combined urbanisation and resource use, pollution levels increased rapidly – especially where growth rates of GNP exceeded 5%. As countries move into a post-industrial (or deindustrialised) phase, the GNP shares of services and associated information technology and services rise. Falling resource use intensity and pollution per unit of economic activity diminish environmental burdens[112]. This is summarised in the so-called Environmental Kuznets Curve[113].

Despite minor variations by country and materials, empirical graphs of resource use intensity (resource use per unit of output) or environmental

[110] Malaska (1991).
[111] A similar pattern in cross-sectional comparisons is modified by the behaviour of developed nations and availability of new technologies and markets – e.g. differential quotas that specifically prevent development of a sustainable value-enhancing industry in cocoa-producing countries. On the other hand, targeting aid programs in places like the Maghreb cluster allow development potentially to leapfrog over the industrial phase.
[112] Unless they are outpaced by 'rebound' growth triggered by falling prices.
[113] Munasighe (2002)

stress vs. income per capita follow an inverted U-shaped curve[114], usually referred to as the *Environmental Kuznets Curve* (EKC). This can be explained[115] by the superposition of three different trends:

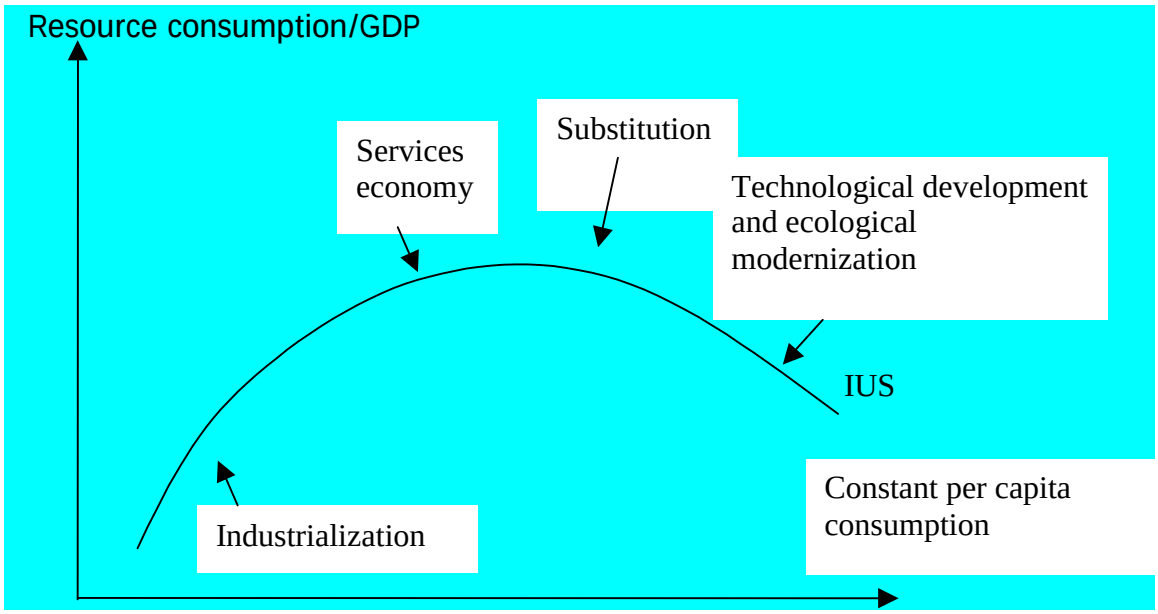


**Figure 9: Intensity of use hypothesis and economic development**

1. Intensity of use (IU): changes in natural resource requirements as the balance of economic activity shifts from agriculture (low IU) to manufacturing and construction (high IU) and then to services (low IU)[116]. For a wide range of countries, this balance correlates (at least partly) with per capita income[117]. The shift to a higher share of manufacturing and construction requires large material investment in building industrial infrastructures[118].
2. Substitution changes the requirements for different types of material. Each follows a demand cycle from initial rapid growth to stabilisation phase and finally saturation. As prices rise and technology advances, cheaper or better materials may replace the original material. The reversal of growth can be so complete that per capita or even absolute consumption levels may decline.
3. Technological development can lead to more efficient use of materials in production of final goods (dematerialisation) or in the satisfaction of consumer wants (immaterialisation).

[114] Malenbaum (1978), Roberts (1996), Kaivo-oja (1999), Seppälä, Haukioja & Kaivo-oja (2002), Kaivo-oja (2002).
[115] van Vuuren, Strengers & de Vries (2002).
[116] Tilton (1986).
[117] Maddison (1989).
[118] The shift to a service-based economy also requires initial infrastructure development.

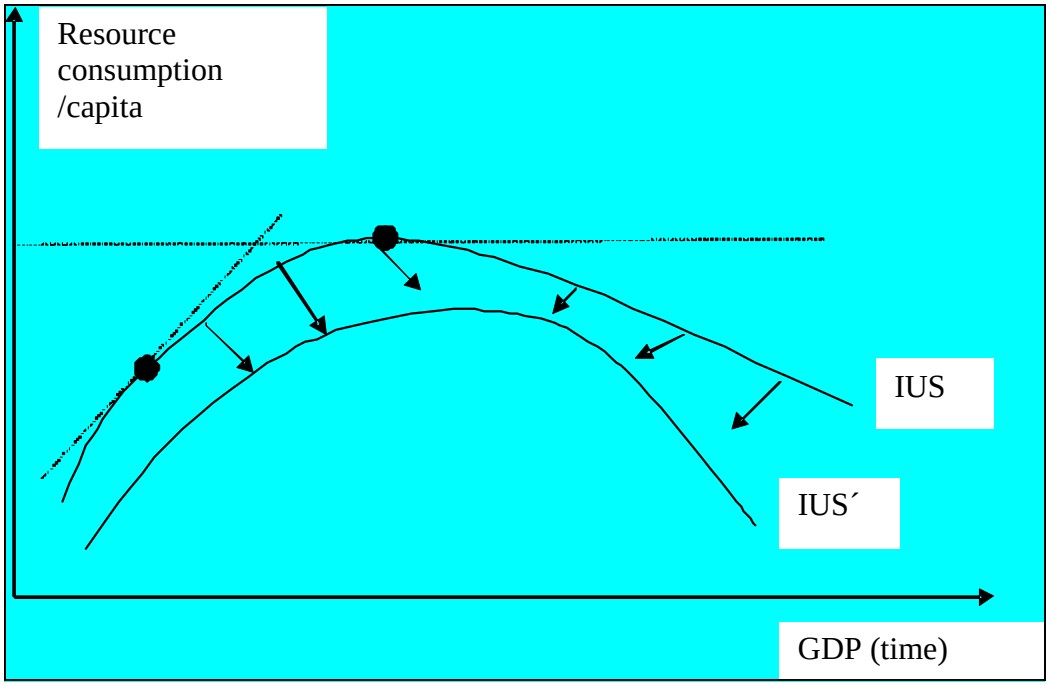


**Figure 10: The influence of technological change on intensity of use**

The impact of technological progress on material demand can be framed in terms of the intensity of use hypothesis[119]: demand for materials is derived from final goods demand. Where raw material costs form only a small proportion of a finished product's cost, they have minimal influence on demand. Instead, income is the explanatory factor in material consumption, giving the inverted U-shaped relationship labelled IUS in Figure 9 and Figure 10. Technological change shifts the relationship between material demand and income downwards. The same economic value can be generated with less material input because of technological improvements in material processing, product design and product development. Late developing countries have less material-intensive development trajectories. In the long run, world material consumption growth should level off and eventually decline – this last stage is called "strong dematerialisation[120]." Only very strong economic forces can drive these dematerialisation processes[121]. At least one study[122] has concluded that e-commerce has the potential for significant dematerialisation and the decarbonisation of at least some developed economies. However, this conclusion has been heavily criticised[123]

[119] Malenbaum (1978),
[120] de Bruyn and Opschoor (1997), de Bruyn (2002).
[121] The environmental Kuznets curve shows two trajectories on the world-wide level leading to dematerialisation: *balanced development* to put all nations well on the right-hand side of the curve, together with *balanced competition* to moderate income growth (and hence rebounds); or massive concentration of development among a few countries, with the rest relegated to permanent positions on the left-hand side of the curve. Here, some form of saturation or active regulatory intervention would be required to restrain the rebound.
[122] E.g. Romm (1999).
[123] Lake (2000).

for overlooking rebound effects - the well-known[124] tendency of microeconomic efficiencies to shift supply and demand curves in ways that result in higher consumption and higher net material consumption. The actual trajectories depend on timing: for example, ISTs cannot necessarily be implemented as rapidly as is expected by technical experts because of the long time scales needed for basic infrastructure investments[125] and because of the delays and costs associated with technology diffusion and adaptation in a more general Schumpeterian 'creative destruction' model[126].

Figure 11 shows a stylised EKC relationship between economic progress (GNP per capita) and environmental risk (e.g. $CO_2$ emissions per capita). Typical developing and industrial countries might be at points B and C, resp. Ideally, industrial countries should seek to increase their environmental protection efforts and follow a future growth path such CE. Developing countries, learning from past experience, could "tunnel" through the peak – preferably below the safe limit representing the maximum acceptable risk of irreversible environmental damage (like climate change or biodiversity loss). The high peak path ABCE could be interpreted as the deviation of private decisions from socially optimal ones. In addition to 'secular' policies (e.g. corrective taxes) operating within the developed countries, collective management of environmental risk could even involve shifting production to developing countries, where accumulated damage and embedded investment in environmentally-destructive legacy technologies and practices may not be so great However, it is not self-evident that different economies will follow either of these paths, in which case, more problem-oriented policies are needed[127].

[124] E.g. Grübler (1998).
[125] Grübler (1990, 1996).
[126] Cave (2003b)
[127] See the detailed scenario analysis framework of Kaivo-oja (1999, 2002) or the more specific macroeconometric approach taken in Ayres and Warr (2003a and b).

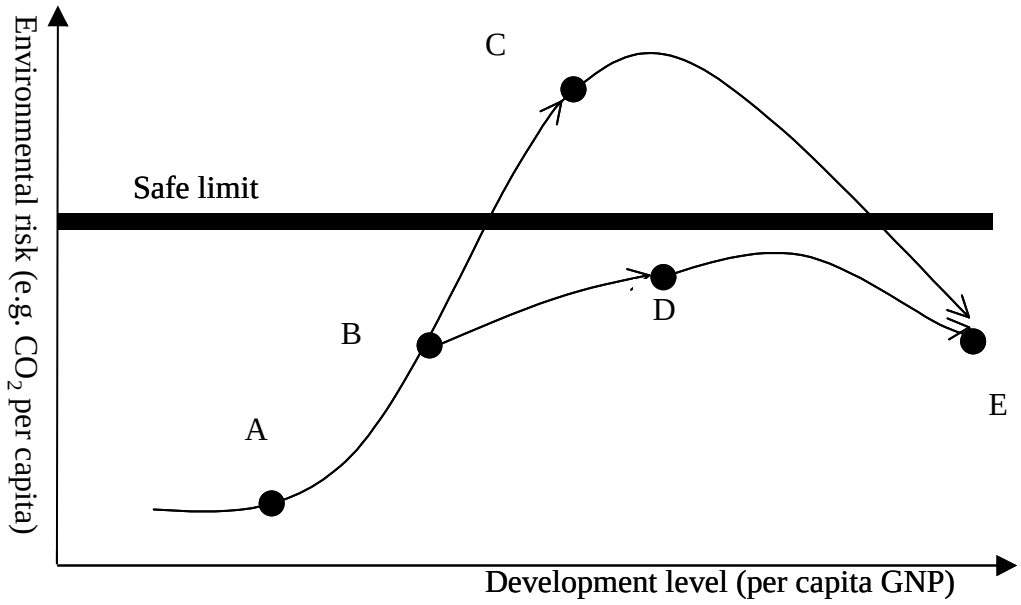


**Figure 11: economic progress and environmental risk**

6.2.2 The ASA approach

To analyse and survey macroeconomic development from different sustainability points of view, the FFRC team developed a well-defined and rigorous information system called Advanced Sustainability Analysis (ASA). The ASA sustainability definition is built on two basic concepts (environmental stress (ES) and welfare (WF)) and ultimately requires nonincreasing environmental stress ($\Delta ES \leq 0$) and nondecreasing welfare ($\Delta WF \geq 0$). Time series of environmental and welfare indicators are divided into separate components related to economic growth, population growth, and material intensity. The ASA system then operates on the dominant relations among these high-level aggregates to obtain insights about sustainability and empirical monitoring information about sustainability trends. Additionally it is used to assess the sustainability of different development scenarios[128].

Starting from the EKC, the sustainability discussion has naturally concentrated on ways to 'de-link' economic growth from resource use[129], mostly through improved eco-efficiency. It does not directly address rebounds and thus embodies a weaker sustainability concept[130]. Figure 12 shows this relationship; de-linking (improved eco-efficiency) lies below the diagonal, whilst ASA sustainability lies in the lower right orthant.

[128] Detailed and comprehensive description of the ASA system can be found in the TERRA2000 Tools Report and earlier articles (Malaska et. al. (2003); Kaivo-oja et. al. (2001a); (2001b); (2002).
[129] Femia, Hinterberger and Luks (1999).
[130] ASA-sustainability requires advances in eco-efficiency to 'outpace' economic growth.

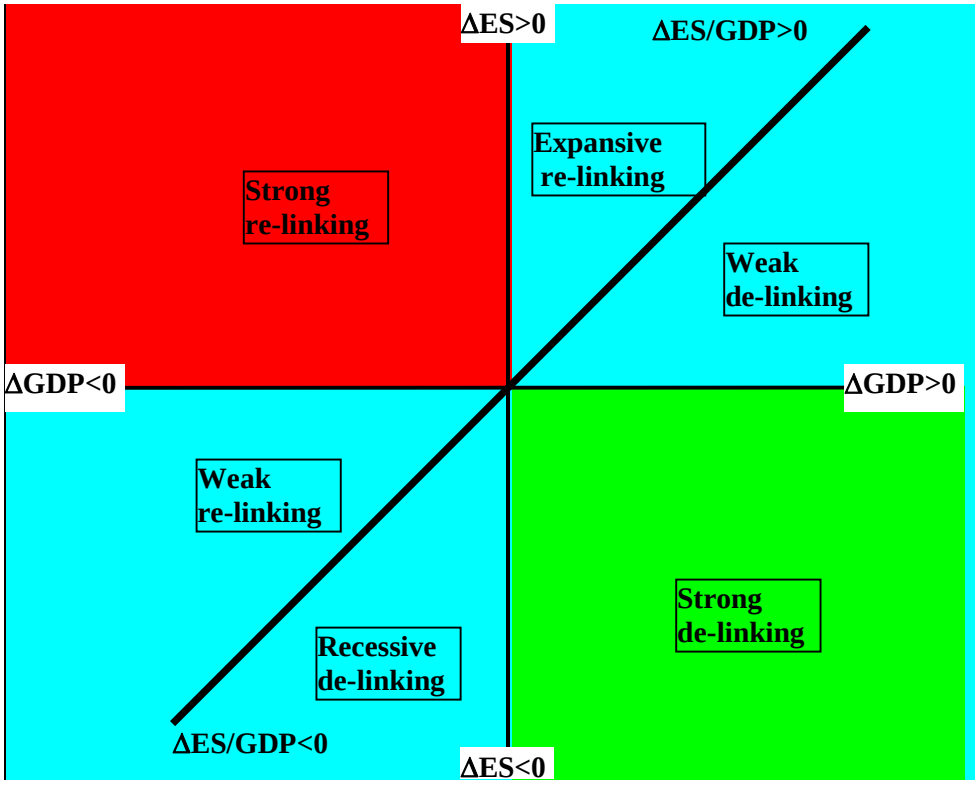


**Figure 12: Degrees of de-linking and re-linking of economic growth**

Since the 1973 oil crisis, the major regions of the world's economy have dematerialised to some extent. By 2000, the GDP volume of the early 1970s could be produced with about 40% less use of natural resources or harmful discharges into the environment. Three basic indicators measure the average annual dematerialisation rate – material flow, total primary energy supply, and $CO_2$ emissions from fuel combustion. It is approximately 1.5% in the industrialised countries. With the exception of China the large developing countries are failing to dematerialise.

De-linking varies with the indicator of environmental stress; Table 6 uses domestic material extraction (DE) in the European Union and Japan. The results are more promising than those shown using other environmental stress indicators. Since 1990, the general trend both in EU and Japan has been strong de-linking of material flows. This indicates clear advancement of sustainability and also demonstrates the need to make focus studies that use different environmental variables in order to diagnose bottlenecks[131].

[131] A complete picture would include induced material extraction abroad; dematerialisation could reflect exhaustion of local supplies and/or substitution of foreign ones.

**Table 6: De- and re-linking of material flows (domestic extraction, DE) in Japan and the European Union.**

| | 1980-1990 | | | 1990-2000 | | | 1980-2000 | | |
|---|---|---|---|---|---|---|---|---|---|
| | ΔDE (Mton) | ΔGDP (billion USD) | Δ (DE/GDP) | ΔDE (Mton) | ΔGDP (billion USD) | Δ (DE/GDP) | ΔDE (Mton) | ΔGDP (billion USD) | Δ (DE/GDP) |
| Japan | 206 | 993 | -0.14 | -218[a] | 433[a] | -0.12[a] | -12[b] | 1427[b] | -0.26[b] |
| EU-15 | 290 | 1513 | -0.12 | -299 | 1475 | -0.14 | -9 | 2988 | -0.27 |
| Austria | 1 | 34 | -0.16 | -4 | 43 | -0.15 | -3 | 76 | -0.31 |
| Belgium[1] | 10 | 41 | -0.05 | 4 | 54 | -0.08 | 14 | 95 | -0.13 |
| Denmark | 37 | 21 | 0.15 | -6 | 33 | -0.29 | 31 | 54 | -0.13 |
| Finland | 26 | 28 | -0.29 | -16 | 25 | -0.45 | 10 | 53 | -0.74 |
| France | 28 | 257 | -0.14 | -52 | 248 | -0.15 | -24 | 505 | -0.29 |
| Germany | -11 | 315 | -0.15 | -191 | 205 | -0.16 | -202 | 520 | -0.32 |
| Greece | 13 | 20 | -0.03 | 16 | 37 | -0.08 | 29 | 58 | -0.11 |
| Ireland | 2 | 14 | -0.47 | 7 | 51 | -0.60 | 9 | 65 | -1.07 |
| Italy | 24 | 232 | -0.09 | -56 | 193 | -0.11 | -32 | 425 | -0.20 |
| Netherlands | 6 | 55 | -0.09 | -39 | 105 | -0.23 | -33 | 160 | -0.32 |
| Portugal | 1 | 34 | -0.19 | 20 | 32 | -0.00 | 21 | 66 | -0.19 |
| Spain | 87 | 158 | -0.08 | 61 | 167 | -0.09 | 148 | 324 | -0.16 |
| Sweden | 11 | 33 | -0.16 | -5 | 31 | -0.17 | 6 | 64 | -0.34 |
| UK | 55 | 268 | -0.12 | -35 | 245 | -0.13 | 20 | 512 | -0.24 |

[a] 1990-1996 [b] 1980-1996 [1] Luxembourg included with Belgium

The bottom rows show the pattern across the EU-15 member countries. The general weak de-linking trend in the 1980s has turned into strong de-linking. However, the general trend mostly reflects the larger EU member countries France, Germany, Italy and the UK. Most other countries have only had weak re-linking throughout the period 1980-2000. This reinforces the need for benchmarking policies and incentives for advancing sustainability in the EU.

The de- and re-linking analysis gives a broad overall picture of the ecological sustainability of economic growth and already suggests some policy lessons for the EU. However, in order to better understand the policy situation the analysis must be deepened and made more comprehensive.

This is done be further exploring the dominant relations. If environmental stress (ES) is expressed as the product of eco-efficiency ($\varepsilon$) and GDP, the ASA-sustainability condition can be reinterpreted as follows: $\Delta ES = \varepsilon * \Delta GPD + \Delta\varepsilon * GDP$ – in other words sustainability requires that the percentage rate of improvement in eco efficiency ($-\Delta\varepsilon/\varepsilon$, which can be called the 'rate of dematerialisation') exceeds the percentage rate of GDP growth

(∆GDP/GDP). The rate of GDP growth, in turn, reflects the rebound effect of efficiency enhancements.

Dematerialisation improves the eco-efficiency of production, and obviously it depends on how well technological development is focused on "green technology" or applied to advancing sustainability through production of the existing bundles of goods and services. The net impact of technology on both growth and environmental stress (in other words the size and logically feasible relationship of ∆GDP and ∆ES also reflect changes in the demand for goods and services. These effects represented through another concept, the immaterialisation of consumption.

### 6.2.3 EU-15 perspective on dematerialisation and rebounds

Global analysis[132] shows that the EU as a whole dematerialised more slowly than the USA and Japan during recent history[133]. This may indicate slower technological development and/or less emphasis on improving eco-efficiency. The concept of dematerialisation is relative and does not reflect absolute levels of environmental stress. Regional dynamics, trade and other interactions determine the relative effects. Moreover, the EU-15 countries themselves differ with respect to these factors (see Table 6). In what follows the EU-15 member countries are analysed using the same environmental indicators as used at the global level.

ASA uses the term *sustainable growth effect* (SGE) to refer to the maximum GDP growth rate that does not increase environmental stress for a given starting point on the EKC path of economic development and assumed growth of eco-efficiency. SGE is logically related to dematerialisation but is a local and notional benchmark like environmental stress and welfare[134]. Realised economic growth above SGE takes place at the expense of the environment and is therefore unsustainable in ASA terms. The ratio of SGE to realised economic growth (SGE/∆GDP) is called the *sustainable growth index* (SGI). SGI≤1 is an alternative condition for sustainable economic growth.

SGI calculations may lead to numerical anomalies if growth stalls or the economy re-materialises; in these cases interpretation of results must be made with the SGE terms. When SGI is less than one, real economic growth exceeds the environmentally sustainable level. When the SGI is greater than one (i.e. greater than 100 %) there is further room for economic growth in the proportion of (SGI-1) without an increase in environmental stress.

[132] See Kaivo-Oja, *et. al.* (2003).
[133] 1980-2000 for material flow and 1973-1999 for energy supply and $CO_2$ emissions.
[134] These concepts also reflect starting points: the impact of current emissions on environmental stress depends on past emissions, while the relative nature of welfare assessments – especially when measured by income - is a founding principle of economics.

Figure 13 analyses sustainable economic growth on the global level[135]. The data show that due to $CO_2$ emissions re-materialisation, India and China have negative SGI values. The USA, Japan and China grew 'too fast' in this sense with SGI values at the end of the research period of 75%, 60% and 20% respectively. Only the EU grew slower than the SGE level. In other words, EU economic growth was fully sustainable in ASA terms – but only in relation to $CO_2$ emissions on the basis of this analysis. Note also that this analysis, being based on an aggregate view of economic growth, does not address the issue of whether such patterns of growth are *economically sustainable*.

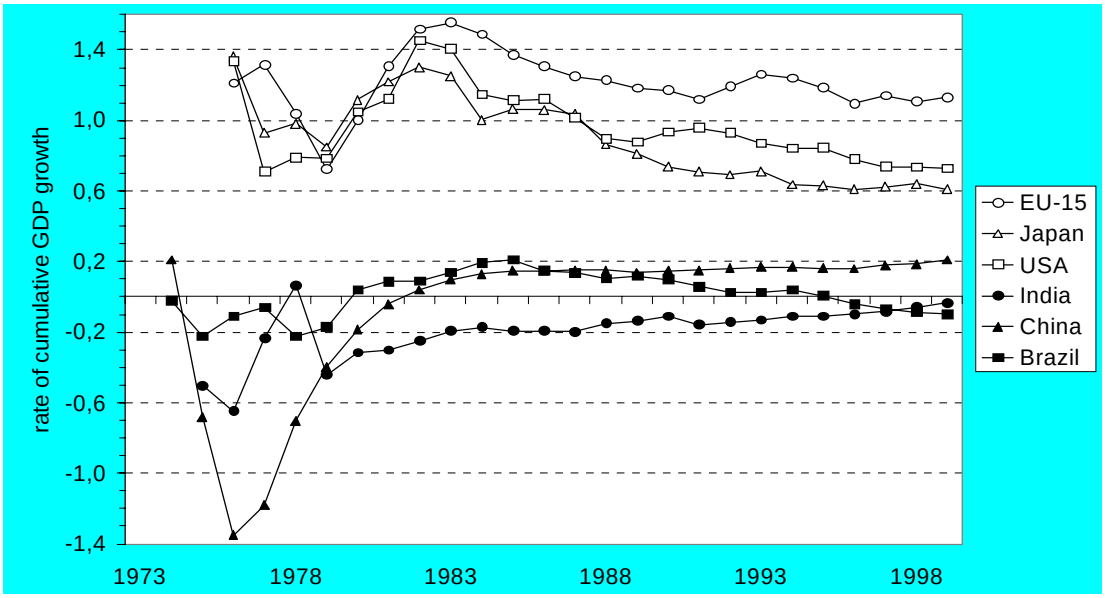


**Figure 13: Sustainable growth index (SGI) based on fuel combustion $CO_2$ emissions in the EU, Japan, USA, India, China and Brazil.**

According to the above analyses, the world's major economic regions have not been ecologically sustainable trends during recent decades – rather, they have been heading away from sustainability. The development of the EU with regard to $CO_2$ emissions can be considered an exception, although the picture is not complete as regards other ES variables. However, there are large differences between the 15 member countries.

## 6.3 TERRA's Work on Determinants of Growth

To go further, it is necessary to examine the underlying economic mechanisms and history more closely, since the aggregate indicators abstract from the internal workings of the system as mediated by economic and political forces. Within the project, the INSEAD team conducted a macro-econometric analysis of the determinants of economic growth, and drew out their environmental implications and the impact of ISTs. The following section summarises some of the main findings.

[135] The EU as a whole, USA, Japan and the developing countries China, India and Brazil.

### 6.3.1 Endogenous growth and rebounds

One important finding was that technology and the resource implications of economic activity are not static, but change over time. This change is not exogenous, but itself reflects economic and other development. Moreover, the impact of a specific technological advance depends on both preferences and institutions and on the prices that signal them. Putting these two aspects together the influence of past economic[136] outcomes on future R&D and the impact of choices among the possibilities currently offered by R&D on next period's outcomes) gives an endogenous growth story. In this story, an efficiency enhancement drives down costs and boosts incomes. The expanded opportunities fund and motivate increased research[137], which drives the next cycle. Combining (e.g. supply-side or technological) choices among feasible paths and (e.g. demand-side or financial) responses to those choices allows us to recognise rebounds as an important engine of growth.

The notion of rebound used here is the positive feedback one: increased efficiency lowers costs of a scarce resource (e.g. energy), which increases demand and thus spurs growth (and possibly more resource use). By the logic of economic equilibrium, rebounds have their own rebounds, which leads to the semantic distinction between partial (immediate or localised) rebounds and general equilibrium rebounds (reflecting the whole system and its dynamics).

### 6.3.2 The lessons of history

The historical record teaches us a good deal about how the growth process has worked and about the relation between ISTs and the environment. Earlier growth phases were associated with technologies relating to power and thus to physical work. Understood in this way, the increased efficiency of provision of physical work associated with the successive technologies of coal, steam, oil and electricity explains most of the so-called ‘growth residual’ – at least up until the till mid-1970's. The last phase (electrification) not only increased efficiency in the physical domain, but also made the Information Society possible, through the emergence of new industries and industrial structures, through deindustrialisation and the growth in information-based services and through the intrinsic correlation between information goods and access rather than ownership[138]. On the evidence, the diffusion and deployment of ISTs would seem essential to any explanation or understanding of the 'growth residual' after the mid- 1970's.

[136] One could include both scientific and socio-political outcomes in the argumentation.
[137] The strength of this effect obviously depends on the effectiveness of competition as Hicks observed in 1935: “best of all monopoly profits is a quiet life”. See also Broadberry and Crafts (2000) for more on the empirical relation between market power and innovation.
[138] Because information can be reproduced at very low marginal cost, legacy systems of ownership-based property rights and associated use of markets to motivate production, distribution, payment and investment have been extensively criticised. See e.g. Rifkin (2001).

The endogenous growth process of increasing efficiency in the use of physical work is also continuing, but is moving further down the distribution chain (to secondary and tertiary efficiency) with dematerialisation and immaterialisation as the most important drivers

### 6.3.3 Policy perspective on resource use and growth

This perspective sharpens our focus on the relation between resource use and growth and suggests some sharper policy guidelines. If resource constraints begin to bind *unavoidably*, the rebound cycle that drives growth and determines *how* technology is deployed can go into reverse[139]. We have already seen how in the mid-1970's, although technology continued to advance, its deployment shifted from labour saving to resource saving. Historically, such partial reversals of the rebound cycle have coexisted with economic growth, but in future we may have to choose between growth and sustainability. In brief, we may not be able to rely on business-as-usual[140] to suggest that each emergent problem will produce a timely and effective solution. At least, we have not only to recognise that the emergence of knowledge endogenous to development but also that the linkages may need sharpening and strengthening.

Much existing analysis and policy separates the world of economics from the physical world. This is one of the 'big lessons' of the research reviewed in Chapter 5, which argues *inter alia* that the economic world cannot sustainably be separated from the social world. The first part of this separation leads us to think of the economy as a mechanism producing good things like growth and income from a set of *abstractions* (production, consumption, labour, capital, resources, knowledge, etc.) which analysts and policy makers interpret as institutions dictate. Thus we have come to rely on growth in GDP, in welfare, in knowledge (e.g. solutions to problems). The second part leads us to think of the economy as an engine for the solution of environmental (and social) problems, with growth as the fuel that allows the engine to operate and policy as the drive train and steering wheel. This perspective is unsustainable.

The alternative is a more evolutionary point of view[141]. The evolutionary paradigm treats the economy as a materials processing system, albeit governed by the laws of supply and demand as well as the laws of thermodynamics. The system consists of processing stages, starting with extraction, conversion, production of finished goods and services, final consumption and disposal of wastes. A description of the system includes materials and energy flows and gradients as well as money flows and price

[139] This observation applies to the resilience of the growth engine, which is an aspect of sustainability that has been too-often overlooked in the literature.
[140] See e.g. Simon (1995).
[141] See also Cave (2002b), Tesch (2003) in which the evolutionary paradigm is applied to GNKS sustainability.

gradients. In this paradigm waste flows are inherent to the economic system. Moreover, damage from the build up of waste flows in the environment can both reduce human welfare directly and increase the cost of finding extracting and processing resources and disposing of waste materials. In this paradigm future human welfare, and perhaps even survival, depends upon adopting proactive policies and strategies to seek and, if necessary, subsidize more benign alternatives to the business-as-usual path on which we find ourselves.

## 6.4 Refinements and Scope for Further Work

The foregoing analysis does not complete the picture. Some additional work carried out within the project examines other aspects of the relation between growth and sustainability at a paradigmatic level. For instance, the EFENIA model[142] examines the consequences of networking (and tele-working in particular) for the extent and impact of resource utilisation associated specifically with the de-industrialised Information Economy. The other computerised modelling frameworks developed for the analysis of the network economy (notably NEMO) were also used to examine some more abstract features of the sustainability implications of IST deployment. Recently, a similar approach has led to the construction of a model[143] that captures the relations between the primarily industrial and service orientated activity considered here and the still-essential agricultural activity. This analysis also brings into focus the role of resources like land and water lying between the global commons of the atmosphere and wholly owned, tradable and exhaustible material input resources e.g. metals). The integrated model[144] was also used to develop and explore a number of policy scenarios considered from a broad point of view that includes the full range of economic, societal and environmental impacts captured within the data. Finally, a theoretical model was developed to examine the relation between management of environmental commons on one side and inequality among nations on the other.

Beyond the integration and interpretation of these specific developments, other specific tasks remain before we can say that we have a practical understanding of the sustainability of the GNKS. These are briefly discussed (in no particular order) below.

The first is to complete the development of the evolutionary perspective. To date, it has primarily been used as a shorthand way of referring to the 'system dynamics' of the GNKS, to remind us that the past remains important and to indicate that qualitatively new phenomena might emerge. More rigorously, evolution is the natural and inevitable result of the combination of

[142] Tulbure (2002).
[143] Tesch and Weiler (2003).
[144] Hughes (2003a).

three processes: variation, selection and heredity. It occurs throughout the GNKS: network structures, human knowledge, economic performance, norms and conventions, technologies, etc. all evolve – or more properly co-evolve. The same abstract analysis tells us what will prevail: that which offers the best combination of fertility, fidelity and longevity - in other words, that which is imitated or reproduced in quantity, accurately and sustainably. If we understand the dynamics of evolution, we can replace the static and unproductive policy metaphors of design and control with more useful and manageable metaphors of intervention. We can also get a better sense of when less-expensive or more-enforceable policies can be devised that exploit rebounds to achieve sustainable development paths that cannot be reached in any other way. Finally, because the evolutionary world is inherently uncertain, we can replace the deterministic view of sustainability with one that explicitly acknowledges shocks, the value of resilience and the premium that recent experience places on flexibility and adaptiveness.

A second task is to drill down below the representation of knowledge as an undifferentiated and universal source of better ways of doing things. To accomplish this task, we must explicitly develop to provide an economic insight into what kind of knowledge the endogenous growth engine produces and how it is applied. This will also 'close the loop' with the human capital and equity analyses, highlight the role of different institutions (including e.g. environmental NGOs) as storehouses of knowledge, and bring the paradigmatic GNKS features of IPR and the interlocking human and semantic webs squarely into focus.

A third development is to recognise the limitations of empirical methods and explore ways to include in the analysis growth that is not 'measured.' This is explicitly recognised in both the aggregate and disaggregated work reported above. The former highlights the concept of the welfare productivity of GDP as an essential link between the welfare indicator on which the propositions of ASA rest and the GDP data that proxy for it. The disaggregated work described in Section 6.3 also notes the unmeasured aspects of growth and the Baumol[145] disease. This links back to the Solow 'productivity paradox' and to the basics of immaterialisation - better (higher utility) and better (less environmental impact) goods and services produced cheaper (prices) and cheaper (resources). This extension would include things that are hard to measure (knowledge, relationships, other intangibles) and things that are not valorised through markets – and thus where there is no way to reconcile (at the margin) different people's evaluations of them.

[145] Baumol (1967) described an economy whose services sector has limited productivity growth potential and relatively inelastic demand. The most productive services firm is the wage leader. In this economy, an increasing share of labour is employed in services. The 'disease' is that total economic growth falls while the relative price of services rises.

Finally, as the comments at the end of Section 6.3.3 suggest, it would be useful for a balanced appraisal of sustainability prospects to move beyond the assumption of assured growth in all areas to consider a world in which growth is not assured, or one where sustainability becomes an objective rather than a consequence (or otherwise).

# Section 7

## TERRA in the Future

# 7 TERRA in the Future

## 7.1 Introduction

The preceding chapters of the Story of TERRA have, of course, dealt with the uncertainties of the future – but they have been uncertainties within known frameworks. (The date of one's death is an example of such uncertainty, but it lies within the known framework that we must all die eventually).

There are, however, uncertainties existing within as-yet-unknown frameworks. This corresponds to Wendell Bell's (1997) 'possible singularity of the future' assumption that not everything that will exist, has existed or does exist, and also to his 'open future' assumption that the future is not totally predetermined.

The past is by far the best guide we have to the future, and many aspects of the future are indeed likely to be simple extensions of features we observe today. However, if we look back into the past as a guide, it is also observable that, at almost any moment in the last few hundred years, we have been on the verge of some change, or invention, or event that has changed the course of the future dramatically. We should expect, therefore, that the same is true today – something is on the horizon that will deflect the course of future events dramatically – but what? We can never know – but equally we can't ignore the possibility. This class of future consideration is definitively not susceptible to trend analysis, and poses considerable difficulties for scenario analysis. Its preferred tool for development in TERRA is thus 'Weak Signals Analysis', supplemented by analyses that relate to concepts (shock etc). Inevitably this class of discussion runs to some extent counter to the accepted wisdom of the day, but the intention of Weak Signals Analysis is not to be controversialist but to be illuminative.

In the process of the transition (emergence) into relevance of things not previously foreseen, we can distinguish three types of emergence:

- The emergence of signals from the background of noise, represented by the Weak Signal analysis described in Section 7.2;
- The emergence of newly emergent issues (or reinterpretations of previously established positions) in the IST/sustainability nexus, represented by the material summarised in Section 7.3.
- The emergence of qualitatively transcendent levels of behaviour in a complex system, represented here by the work on network topology;

outlined in Section 7.4.

## 7.2 Weak Signals – some TERRA Examples.

### 7.2.1 WSF #1: Welfare saturation

*Description*: There is an implicit link between GDP/capita; welfare; and consumption. These are rather loosely assumed to follow trajectories that are at least sub-parallel. However, many commentators assert that welfare has become de-coupled from GDP increases and is static or declining in many developed economies[146]. That assertion can, however, be read as no more than a re-definition of welfare in non-monetary forms. Nonetheless, new data shows that some basic consumption (e.g. of energy) may cease to rise with GDP/capita after a certain point[147]. Taken together, these two related possibilities might be taken to mean that there exists a level of GDP/capita (not necessarily fixed over time) that represents 'Welfare Saturation', beyond which neither welfare nor certain elements of consumption increase with increasing income.

*Potential Implications*: The existence of a concept of welfare saturation would introduce a number of consequent changes in perception in different domains:

- Economic At the point of saturation, the rational buying behaviour of *homo economicus* would apparently change – but to what? Behaviour seems to derive from values and beliefs – so what changes here? The aspiration element in motivation must somehow be affected – but how? And what new buying patterns replace the old? Does this accentuate (or even in part account for) the shift from goods to services?
- Sociological Money may never have bought happiness, but nonetheless the fallacy seemed to work for many people. If happiness levels peak and then either remain static or fall, does life become a certain route to disappointment? Is the prospect of some sort of 'betterment' a necessary part of the condition of man (as in 'life, liberty, and the pursuit of happiness') or is stasis a comfortable state (as in 'liberté, égalité, fraternité')?
- Environmental If there is an upper bound to the consumption of energy per capita, then there is an implied upper bound to e.g. the creation of pollution. This is superficially a good thing; but then will that upper bound become, in its turn, the accepted norm when developed nations negotiate on emissions? And what (presumably immaterial, or at least less material) consumptions will occur post-saturation? The Rebound from immaterialisation is an income effect, so a multiplier on the original

[146] E.g. Daley and Cobb (1994) especially chart on p 464 and surrounding text and tables.
[147] Shell (2001) especially diagram on p31.

situation of excess income. Does the excess income become meaningful investment? Or support more but different pollution?

- Cultural Anecdotally, interest in eastern, non-material, belief systems is on the increase in developed nations. Do cultural alternatives relate to welfare saturation and post-materialism? Hardt and Negri[148] postulate an introverted, post-material dialectic as a necessary new foundation for political philosophy. Marxism has long seemed to be dead, but perhaps capitalism is following it to the grave: if Hardt and Negri are the best guides we have to the future, then politics as a whole is in trouble.

*Tracking Indicators*: Many indicators exist for welfare – possibly too many. ISEW is one that seems directly relevant. Energy use is also widely tracked. The interest here, however, is at the margin – at the moment of welfare saturation, if it exists. Tailoring an indicator for the purpose would involve hypothecating post-saturation activities (e.g. an increased interest in spirituality) and tracking them (e.g. the growth of the 'spiritual' sector).

*Related Phenomena:* There is a strong link here to the second entry in the WSF file – The Fifth Wave. If, as weak signals may indicate, the Fifth Wave were indeed concerned with 'The Extensions of Man' in the intellectual, sensual, and spiritual senses then this would tend to support the 'Welfare Saturation' hypothesis. The third WSF entry, The New Subjectivity of Money, may also relate through the concept of Hedonic Indexing if (as some more enthusiastic protagonists claim) the New Economy is actually the fallacious result of an erroneous belief in the existence of Welfare increases that have not already occurred. Much is open to dispute, but there is enough activity to demonstrate a 'Weak Signal' here.

*Observed Signals* (in the press etc): For a view on the overt search for happiness as welfare saturation approaches, see Diane Coyle's article (concluding 'the dismal science of economics is turning cheerful') the Independent (UK) 28.03.2001. See also the references, particularly the figures in the Shell Scenarios.

### 7.2.2 WSF #2: The fifth wave

*Description*: The Information Society is not infrequently taken to be the 4th Wave of Kondratieff[149] (or sometimes the 5th, depending on the manner of counting)[150]. The waves originally postulated by Kondratieff seemed to have a period of about 60 years, but more recently it has appeared (e.g. to Schumpeter and others) that the wave length may be decreasing so that the 4th Wave may only have a life of perhaps 40 years or perhaps even less. At the extremes of the range of fore-shortened predicted figures, the 4th Wave could trough at about 2020 - and could already have peaked. If that is the

[148] Hardt and Negri (2000) 'Empire' – Harvard College U.S.A.
[149] Kondratieff (1926).
[150] See Freeman and Louca (2001) for a survey of Long Waves in general.

case, and if we are thus already in the decline phase of the Information Society Wave, what might be the clues available to us about the nature of the forthcoming successor Wave?

A Kondratieff Wave is no small phenomenon: the more enthusiastic protagonists of Long Wave Theory see its influence in every aspect of life[151]. Such a vast wave should already be visible, if only as a speck on the horizon. The 'core' of a wave has, in the past, lain in socio-technical development triggered by the coming to maturity of some aspect of scientific advance; it has directly affected the day-to-day life of the vast majority of individuals in developed nations; and it has dominated the economics of its day. Perhaps most significantly, one can (with full hindsight) see in each previous case the evidence that the wave was inevitably coming, everywhere in view but unrecognised as to its significance, as each wave tends to prefigure the next long before the arrival of the wave concerned. What then do we see today that meets these criteria? What is it about today that prefigures tomorrow yet goes unrecognised?

McLuhan[152] was fond of describing media technologies as being 'Extensions of Man'; television was an extension of our ability to see, for instance. McLuhan's 1951 vision of the then-coming information wave (made at or before the peak of the previous wave) also offers clues about the successor waves. Quite possibly the largest single business worldwide at the peak of the current wave is illicit pharmaceuticals (or 'recreational drugs'): a huge anomaly in the Information Society, but one which is effectively devoted to McLuhan's prosthetics: extensions to mans' ability to imagine; to enjoy; to perform athletically etc. Perhaps even more surprisingly, elective surgery (a natural but more radical companion to elective medication) has become commonplace. The old prosthetics (spectacles were possibly the first consumer item to go beyond the essentials of life) have been monstrously extended - breasts and lips are enhanced, and stomachs and thighs reduced, as a commonplace. (For a scenario that features elective physical modification extensively see Gibson's Idoru[153]). Cloning and the bio-chemical revolution are potentially imminent; and Kurzweil foresees synaptic mapping as a long step on the road to a Nietschian Ubermensche. At the same time 'spirituality' - the New Age', alternative religions, meditation etc, have come to new prominence, and counselling and personal development are all around us.

There is at least some plausible evidence, therefore, that the successor wave will be a further step on the road to the conquering of physicality - a further

[151] As in TERRA-related document, Gaus (2001).
[152] This theme dates from McLuhan (1951).
[153] Gibson, (1996).

Extension of Man. (This would also chime neatly with the internalisation of the political dialectic foreseen by Hardt and Negri)[154]

*Potential Implications*: With previous Long Waves, each new Wave has been additional and complementary to its predecessor, which declines only slowly. A half-period (perhaps 20 years) is likely to elapse before the full effects are realised.

- Economic Much of the existing activity in this sector is currently in the 'Black Economy', although 'laundering' allows some to appear as spurious increases in other sectors (the entertainment sector being apparently particularly favoured). It seems hardly possible that this situation can continue, but equally unlikely that a single over-night change will bring it totally into the visible economy. Filtering in over time will (perhaps) seem like growth, but no growth will be present. How will this affect the economy as a whole? Many factors already exist (see WSF #3) that allegedly give such spurious impressions of growth – is the successor wave merely a part of this new subjectivity of money?
- Sociological The 'Extensions of Man' in the successor Wave may possibly provide the new (replacement) focus for betterment as part of normative aspirations. If so, then perhaps Margaret Thatcher was right and there is (or at least will be) no such thing as society.
- Environmental Assuming that physical prosthetics are recyclable (as is the case with gold teeth) then 'Extensions of Man' may prove to be a benefit from an environmental standpoint. Previous Waves have often been marked by a physical monumentalism whose decline into less material values might result in reducing the 'A' factor in the I=PAT equivalence.
- Cultural The successor wave postulated would present most visibly in the Cultural sector: counter-Culture would prevail, but counter-Culture is a very heterogeneous, fractured, sqabblesome thing. Seen as an overlay to existing cultures it would be anarchic but not necessarily destructive: the pre-existing cultures might survive almost unmodified.

*Tracking Indicators*: Despite its 'black' status, some good data sets exist to track illicit pharmaceuticals – seizures in particular. Elective (cosmetic) surgery is a trackable sector, as is that of social 'Counselling'

*Related Phenomena*: The 'spiritual' sector concept aligns with WSF1 (Welfare Saturation).

*Observed Signals*: "Despite past avowals that narcotics trafficking in China had been eradicated, China now concedes that it's been waging a losing battle against illicit drug use. Seizures of heroin and marijuana increased 34%

[154] Op Cit in Weak Signals #1 – Welfare Saturation.

and 137%, respectively, in 1998, and the number of addicts is estimated to have increased almost ten fold in the past decade. Rising unemployment and poverty due to the slowing economy and public sector reforms are considered partly to blame. Ironically, in a country in which drug traffickers oftentimes face immediate execution after public trials, some restaurants are giving a nod to the drug culture by offering dishes seasoned with a few grains of opium[155]."

## 7.3 Emergent Analytic Issues

Many papers have been produced in TERRA expanding on newly emergent issues (or reinterpreting previously established positions) in the IST/sustainability nexus.

### 7.3.1 Analytic reconsiderations

Six such topics were gathered together in a series of 'occasional papers' for TERRA. The first examines the importance of knowledge diffusion – specifically best practice – in accounting for the UK's relatively poor productivity growth in comparison to experience in the United States and Germany. It argues that the UK could make major improvements in productivity by adopting best practice, but identifies barriers to the effective adoption of the best techniques, with skills being the most important.

The second presents a high-level summary of the economics of human capital and the derivation of wage equations reflecting the impact of human capital on labour markets.

The third summarises some known facts relating to enterprise and high-tech small and medium-sized enterprises (SMEs). It looks in particular at the relative innovation performance of differently sized firms. The very smallest firms have dominated the growth of the SME sector in the UK for the past 15 years. But this growth, together with training and innovation has recently waned. This raises a policy challenge, especially as labour and management skills are now more important limits to growth than finance. High-tech firms are heavily embedded in networking and collaborative arrangements. It is thus important for policy to emphasise systemic issues. Moreover, this raises an important question about the balance of policy objectives between overcoming barriers to growth in small high-tech firms and influencing the network and collaborative infrastructure in which they work.

The fourth examines the economics of technical change and innovation and related policy issues. It takes as a central variable the global knowledge stock

[155] 'Bewildered China Faces a Surge of Drugs,' Agence France-Presse, 1 July 1999. Many more forward views are to be found on http://www.csf.colorado.edu/longwaves.

considered in the Human Capital theme (and NEMO before it) and examines the implications of its partial public-goods character. It also incorporates the recent literature showing that growth is faster in nations 'catching up' with those on the technological frontier, and draws the implications for European scenarios and policy.

The fifth essay documents a quick panel study of the relationship between schooling and growth performed using the Barro-Lee data set and other data, which supports the idea that (measured) educational *quality* is more important than (measured) educational *quantity* in explaining GDP growth.

The sixth essay collects some observations on the relation between inequality and growth from an economic perspective.

### 7.3.2 Technological change and R&D

This short piece (the fourth in the list above) is offered as an example. It examines the economics of technical change and innovation and related policy issues. Many papers address the importance of R&D and technical change in growth. The general thrust of the relation between productivity and technological performance is well known and data are available elsewhere.

The core concept is the knowledge stock. This is not simply defined, but may be considered to be global and to encompass the sum of ideas relating to basic scientific and non-scientific understanding and their applications in technological and non-technological activities. This global knowledge stock may be expected to increase over time through many ways but most notable will be

- World scientific activity;
- Other R&D activity; and
- Experience and the use of knowledge (thus overcoming any tendency to rely on the outmoded linear model of innovation).

It may be worth noting that to some degree the forces that drive certain additions to the knowledge stock (scientific knowledge) - essentially peer esteem - may be very different from those that drive the use of that knowledge - expected private financial returns. There is not necessarily therefore a close relation between user needs and supplier provision of knowledge.

Economic actors - nations, firms or individuals - draw on the global knowledge stock and as they embody such knowledge into their economic processes so output and productivity increase and growth proceeds. Use of knowledge can

come about through taking ideas and then building products and using processes (including new management methods) that embody them or by buying and using products and processes in which others have already embodied knowledge. Accessing and using the knowledge stock is the process of technical change.

Past literature suggests that technical change thus defined is at least a major driving force of growth and productivity. Knowledge is considered to be *non-rivalrous* in that use of it by one country, region or individual does not prevent its use by another country or individual (Arrow, 1962). In addition, the use of knowledge is not a zero sum game: if all used the knowledge all *could* be better off. However, there are advantages to being ahead. Having a technological lead, by using later knowledge or using knowledge more effectively than rivals, yields extra benefits whatever the level of technology. A leader will typically[156] be richer than a follower. If a follower catches up, the follower will become better off but this will happen partly at the expense of the leader's prosperity (Krugman, 1995). If a follower falls further behind it will become worse off. For an individual country therefore, growth and productivity benefits arise through technical change, but having a technical lead means even greater levels of output and productivity for the leader than if all countries had the same technological level.

For an individual country technical change may involve either catching up – and moving towards the knowledge frontier – or, if the country is already on the frontier, maintaining a position on a moving frontier. Clearly, backward countries that have the opportunity to move towards the frontier have greater growth opportunities than those already on the frontier. For example, until recently Japan was able to grow very fast as it caught up - its growth has now reduced considerably. However, catching up will not necessarily enable countries to pass those already on the frontier. In fact the catch-up may reduce the output levels of the leaders as their technological lead is reduced.

The key issue is how may countries successfully access and utilise global knowledge stocks or, to put it another way, how might some countries be more technologically progressive than others? Jones (1998) emphasises the importance of infrastructure and incentives (for example, low crime rates). This suggests that economies where private incentives are strong, risk capital is available and education levels are high have an advantage in assimilating and utilising knowledge.

At a more detailed level:

- If *knowledge is tacit* then experience matters and success breeds success.

[156] Some situations show "second-mover advantage," but we do not go into these here.

- If *complementary inputs* are important to knowledge assimilation and use then high skill levels in the work force and perhaps clusters will be important.
- Own knowledge generation activity (R&D) may be necessary to understand the knowledge available in the global pool.

An effective IPR policy may be essential to effectively benefit from domestic additions to the global knowledge pool. If the knowledge pool is global, why should any country bother to spend on R&D rather than free-riding? The reasons for spending on R&D, and thus avoiding the Tragedy of the Commons, are that in addition to adding to world knowledge stocks, for a single country or region R&D:

- Facilitates understanding and assimilation of other knowledge[157] in the world stock;
- Creates labour skills that enable effective use of knowledge; and
- Enables that country or region to be first to acquire and use additions to the world stock of knowledge, thus securing the first move advantage.

Will greater R&D yield higher output, productivity and growth in a given country? The literature accepts that R&D yields higher growth and output levels, however, there is considerable controversy as to whether such increases are persistent – some recent growth shocks have died away quickly. On the evidence, R&D matters (at least for a while) but not only R&D will matter. In many areas of economic activity, Europe may well not be on the knowledge frontier; as a result, catch-up is feasible. R&D can contribute to this, but other policies relating to catch-up may be at least as important. In other areas, more R&D may enable Europe to lead more effectively and so contribute to improved performance. To the extent that R&D means earlier and more extensive use of technology, Europe will benefit.

What else besides R&D matters? Undue or single-minded emphasis on R&D places excessive emphasis on the generation of technology rather than its use. As IPR protections and persistence of technological advantages weaken, use or diffusion increase in importance. R&D may affect them, but so do other factors including:

- Availability of long-term finance for technological investments;
- Availability of start-up capital for new firms;
- Availability of skilled labour;
- Attitudes to risk;

[157] Cohen and Levinthal (1989) argue that R&D has two faces. It both develops new knowledge and also enables firms to assimilate knowledge originating elsewhere.

- Macroeconomic conditions;
- Information spreading mechanisms; and
- Tax and policy environment.

However, greater R&D or faster catch-up will not necessarily yield to measurable increases in the growth rate. To some degree at least, what matters is performance relative to competitors; if they also speed up Europe may be running faster to stand still. A wealth of data shows how world R&D has been increasing. A region that wishes to retain a technological lead may therefore have to *increase* R&D in order just to stand still. Jones (1998) notes that in the US between 1950 and the mid 1990s the fraction of the labour force engaged in R&D increased by a factor of almost three. However average growth rates of output and productivity in the US are no higher today than they were from 1870- 1929 (one should note that Jones does not attribute this to the cause stated here).

This has two additional ramifications. First, to the extent that technological advance requires innovators, it suggests that growth in this type of human capital supply is needed to retain a growth advantage (not merely an adequate level of supply, as argued by Schumpeter). Second, equilibrium reasoning suggests that scenarios of sustained widening gaps between technological leaders and followers are improbable: the fruits of R&D investment will tend to be dissipated by competition for the technological lead, and in the long run the only reliable benefits are global.

As R&D and related activities are investment activities, such increased investment – while possibly generating higher output - may not necessarily generate increased consumption and welfare.

OECD data show that European countries sit some way down the international productivity growth league tables, and have probably been falling further behind in terms of (R&D):(GDP). There is thus significant opportunity for Europe to do better in terms of both R&D and technology diffusion. It is unclear what is actually required. For example, it is not clear whether Europe requires more R&D; a higher(R&D):(GDP) ratio; more R&D relative to competitors; or a growing (R&D):(GDP) ratio relative to competitors.

Finally, to seek more R&D or faster diffusion is a very different thing from finding a mechanism to do so. Much of the academic technology policy literature is microeconomic in orientation and primarily concerned with market failure. Such literature thus asks whether government intervention can reduce market failure and increase welfare? The approach taken here is more macro orientated and driven by international comparisons. It is not necessarily the

case that poor comparative international R&D performance, for example, is necessarily the result of market failure or that policies aimed at repairing failing markets can solve the problem.

The list of policy instruments is well known to all:

- Tax incentives to R&D (or the less-common alternative of levy grant schemes) – though there is considerable dispute as to the cost effectiveness of such schemes.
- Policies to make capital markets more long-termist (e.g. modifications to anti-trust legislation) or turnover taxes and extensions of venture capital.
- Improved skill supplies and further investment in trained and scientific personnel.
- Encouragement of inward investment to transmit best practice.
- Risk-shifting launch aid schemes
- Macroeconomic stability (although to date this has not worked well)
- Effective IPR policies to enable early domestic exploitation
- Reconsideration of defence and high-tech bias in government R&D spending.
- Improved access to scientific expertise for potential knowledge users.

There is no easy fix, and these policies must be integrated with others - some on a global scale. None of the literature appears to suggest that raising the rate of technical change in an economy, especially mature economies such as Europe or the US, can be achieved quickly or easily.

### 7.3.3 A policy rethink: propriety of intellectual property rights[158]

The work in TERRA exemplified by the example above leads inevitably to the largest area of reinterpretation of existing understanding arising from the growth of the Information Society, the field of Intellectual Property Rights. IPR is a topic coming to the fore at all times of technological change (Jefferson and McAulay defined the state of patent law at the beginning of the second Industrial Revolution for instance) so it is hardly a surprise that it should be central to the IST story; what is perhaps more surprising is the close relationship between the current debate and the debates of the 19th century. The note following summarises TERRA's work on IPR.

> "Why have property? Property feels right to many of us because of a sense that each of us should own the fruit of our labour. But this is at least not the whole story, because some property - such as land -

[158] Some of the ideas in this piece are developed at greater length in Boldrin and Levine (2003), Tesch and Descamps (2003) and Cave (2003c).

> wasn't created by its owners. Say there's a large stretch of land that's commonly owned, such as the West of the U.S. once was. The government decided to open the land for private ownership. It didn't have to do it; it could have kept it as a giant park, and no-one's property rights would have been harmed. But it gave or sold the land to people who didn't create it, thus limiting the freedom of action of all others. The reason for this was incentive: If people have the right to exclude others from their land, they'll have more incentive to invest effort in improving the land - build homes, plant crops, and so on...So far, the argument tracks copyright and patent law quite well. The theory of intellectual property is likewise that giving people the right to exclude others from new works or inventions will give people an incentive to invest effort in creating and inventing.[159]"

The Global Network Knowledge Society runs on ideas and information. Instead of deeds and fences, it has copyrights and patents. We have tended to think that ideas are public goods and thus that ownership rights need to provide special kinds of protection. We also think that exclusive IPR are both necessary and appropriate for innovation and development of ideas. However, there are grounds for arguing that neither of these propositions is true.

An idea in my head has value in use (I can exploit it to make things) or exchange (I can communicate it to those who might use it). Before I do these things, it is a private good - rivalrous (since only I can use it) and excludable (since I can keep shtum). Communication is an act of production (using private inputs: the idea and the teacher's and students' time) - it produces a new private good (the idea in your head). Ideas embodied in our minds are even more private than a house or plot of land, which would at least survive if the owners died.

In contrast, a disembodied abstract idea[160] has no economic value. This means that the economically valuable instantiation is a copy of an idea[161] (which leads back to the mimetic evolution business). This brings us to rights. If my copy of an idea and yours are separate entities, my use of mine does not affect your use of yours. This does not make them public goods any more than my use of a CD affects your use of your copy of the same CD. Oddly, IPR does not merely replicate the property rights for 'real' property, but goes well beyond. If I sell you a car I would not seek to tell you where you could drive it or for what purpose - but IPR seeks to do that[162]. Your right to control *your* copy of your idea does not need a great deal of protection. IPR is concerned with your right to control *my* copy of your idea.

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[159] Volokh (2003).
[160] Ayres and Warr (2002) analyse the role of such abstractions in neoclassical growth theory.
[161] See Blackmore (2000) for an exposition of the evolution of ideas through copying.
[162] This is largely limited to the IPR system *per se*. As Botterman, *et. al.* (2001) point out, such restrictions are not allowed in e.g. Freedom of Information requests.

IPR may be seen as a (default) contract rather than a right. But such a contract would normally be regarded as illegal, inefficient or unethical. First, *legality* - in any other context, contracts prohibiting reuse[163] would probably be seen as anticompetitive and illegal. A refinement of the counter-argument portrays IPR as a voluntary 'default contract' that saves transactions costs. But such IPR "contracts" are difficult and costly to implement or enforce. This *inefficiency* is perhaps the most important reason for limiting any arrangement that tries to restrict subsequent rights of buyers of ideas. Comparing codified with tacit knowledge[164], this is exactly why people are allowed to rent out their labour but not to sell it. Labour and ideas (as economically valuable things) are attached to persons, so enforcing sales contracts requires unethical, intrusive and very expensive methods. Even software or books become your private property once you have bought them and the seller's other rights should be exhausted at point of sale. If this is inappropriate in some cases[165], you could lease ideas, borrow them from the library, etc. The intrusiveness required can be extensive: in Bright Tunes Music Corp. v. Harrisongs Music, Ltd. [420 F.Supp. 177 (1976)][166], the court ruled, "His subconscious knew it already had worked in a song his conscious did not remember... That is, under the law, infringement of copyright, and is no less so even though subconsciously accomplished."

This is one reason why the IPR debate is closely linked to the privacy debate. 'Software audits' and enforcement actions against 'pirates' are not only intrusive and costly, but also often paid for by third parties (taxpayers, ISPs, computer manufacturers). The fundamental issue regarding voluntary contracts is whether all affected parties have a say. If you buy software and, breaking your agreement, sell it to a third party, they are still bound by the original agreement. If you do this using my network, I am liable for violating a contract I never agreed to in the first place. There seems little justification for the IPR laws as written and enforced.

But what about the incentive argument for exclusive rights? We don't usually look beyond the terms of sale for incentives - we want innovation and development in making chairs or growing potatoes, but we don't rely on exclusive state-granted monopolies to reward this. In the view sketched above, ideas are like machines that can be used to produce useful things. If we could scale them up or down the way we scale machines, we could simply abolish IPR and harness the power of free enterprise to de4termine the correct amount and allocation of ideas. We would get socially valuable ideas would be used as widely as was appropriate. There would be no more need for IPR than for laws allowing the makers of breakfast cereals to control how

[163] David and Spence (2003) discuss the impact of EC Database Directive re-use prohibitions.
[164] See e.g. Cave, Hughes and Mesarovich (2002).
[165] For instance, in recognising the moral right to be identified as author of a work or to make limited use of the idea, where the purchase transfer of right is 'too big.'
[166] Cited in Boldrin and Levine (2003).

I chose to eat it. But ideas are not neatly divisible - two half-ideas does not make a whole one.

Can the sale of ideas without monopoly power sustain innovation[167]? Here is a standard argument[168]: "A good argument for copyright in music. You've just earned a $250,000 advance for your rock band, and you don't see any real profit from it...without copyright income the artists would be deeply, deeply in debt, or more realistically would never have the chance to record in the first place." But in fact the innovation took place despite the poor reward, so the *a priori* case for monopoly is weak. Moreover, the essential indivisibility is the cost of the first copy - which Information Society Technologies have drastically reduced - just as they have the costs of subsequent (even 'pirate') copies. In fact, many people could modify existing work or create their own.

What keeps this flow of innovation in check? That's right - IPR. One cannot begin by modifying existing work because it is locked up for the foreseeable future - the shoulders of giants[169] are fenced off. If they want to make brand new material, they have a steep entry barrier, compounded by the allocation of access to distribution channels on the basis of distributors' expected future IPR income[170]. This biases innovation in favour of profitable 'product' and, in turn, against really original output. But really new output is the only kind that can avoid the existing 'protections.'

Ultimately, these considerations suggest that "intellectual property" debate is not about creators' rights to the fruits of their labour, nor the incentive to create, innovate or improve. It is about the "right" to preserve existing business models. In 1939, Robert Heinlein's judge in Life Line observes:

"There has grown up in the minds of certain groups in this country the notion that because a man or corporation has made a profit out of the public for a number of years, the government and the courts are charged with the duty of guaranteeing such profit in the future, even in the face of changing circumstances and contrary to public interest. This strange doctrine is not supported by statute or common law. Neither individuals nor corporations have any right to come into court and ask that the clock of history be stopped, or turned back."

[167] See Tesch and Descamps (2003) for a policy proposal based on this insight.
[168] Cowen (2003).
[169] Scotchmer (1991) argues in favour of modification, re-use and cumulative innovation.
[170] Recently, exceptions have begun to emerge in the world of peer-to-peer music sharing (Times (2003)) and open-source software.

### 7.3.4 Network dynamics – a topic for the future.

A lot can be said about the characteristics of even seemingly random networks as long as some facts about the rules by which they are created, or their dynamic is driven, are known.

This leads to the understanding that information about emerging properties of networks can be found scientifically, so that using this information it might be possible to establish which frameworks can be created to steer the structure of the network (within known boundaries), that is as different environments influenced by and influencing the network dynamics.

TERRA's work on this topic was substantial but essentially exploratory, representing a response by the project to changing perceptions of the importance of network dynamics in work at the IST/SD interface. The Nautillus tools illustrated below are representative of an important area for future work following TERRA, rather than a completed TERRA task. They are located as the final note in the Story of TERRA as an apposite reminder that TERRA's work is of a type that can be (and is) finished, but which necessarily can not be (and is not) completed. There remains always much to be done: the editors of this document conclude with the hope that the work of TERRA will continue, albeit in different guises.

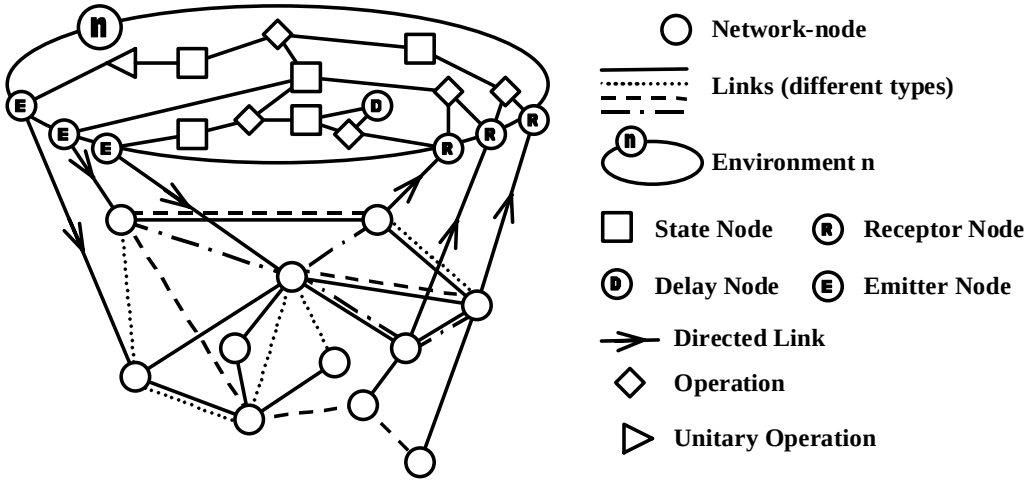



**Figure 14: Graphical Representation of Networked Dynamics**

This provides a framework aiming at integrating the more traditional "system dynamics"-like modelling with the newer actor based modelling techniques.

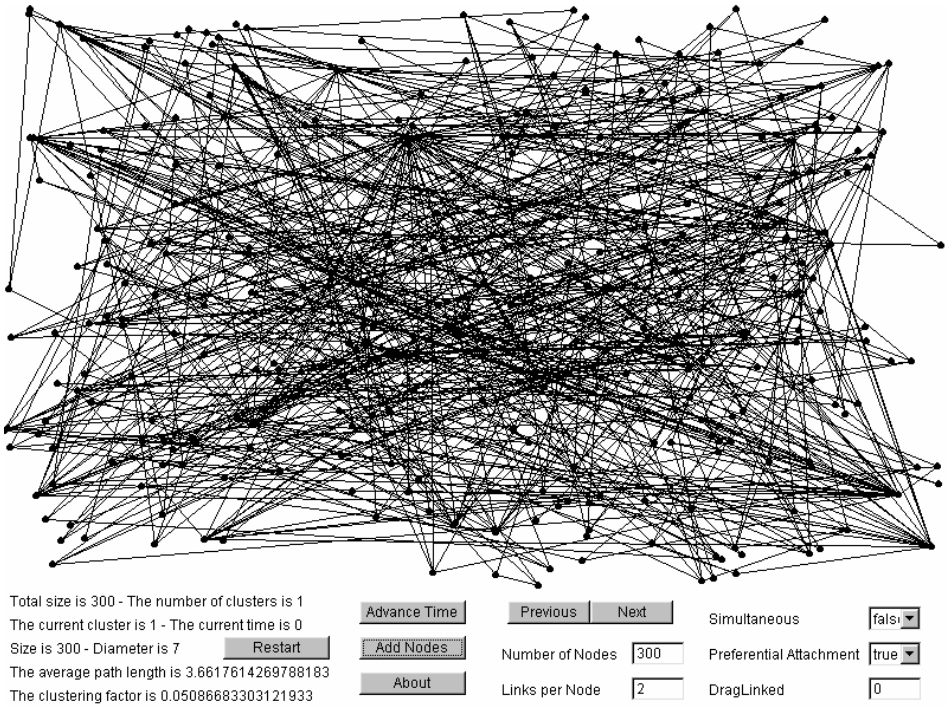



**Figure 15: The NAUTILLUS© Networking Applet: a Random Network**

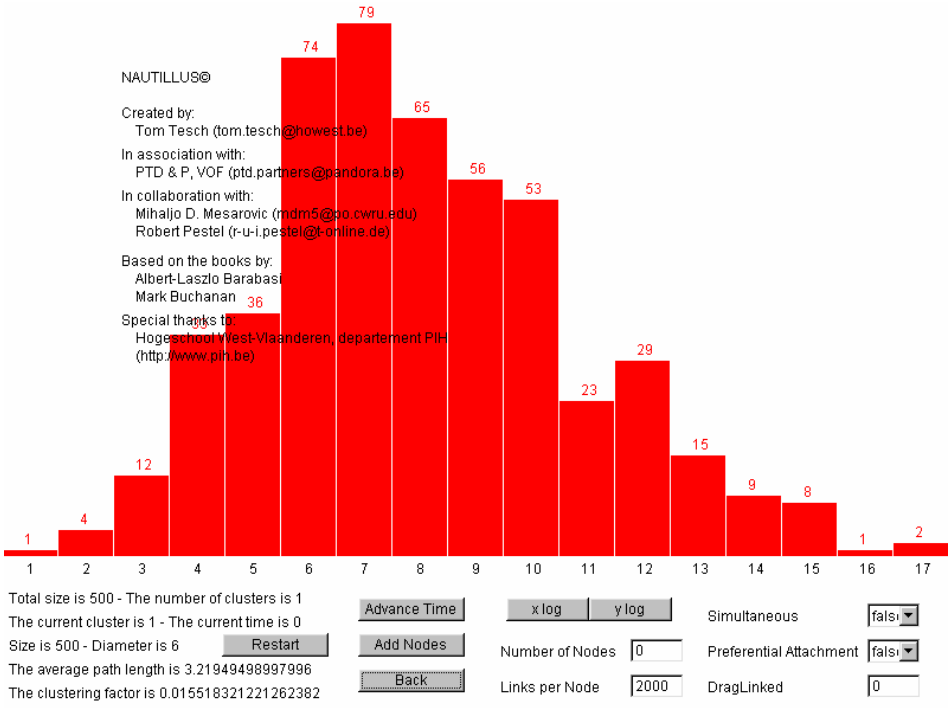



**Figure 16: The NAUTILLUS© Networking Applet: Link Distribution Graph**

# I Appendix I: Concept Sheets


## TERRA CONCEPT SHEETS

### I.0 The purpose of Concept Sheets

TERRA Concept Sheets cover a range of key topics in the area of the relationship between the new technologies of the Information Society (Information Society Technologies – ISTs) and sustainable development:-

#1 What is Sustainability

#2 The Relationship of the Information Age to Sustainability

#3 Globalisation and the Network Society

#4 Lifestyle, ISTs and Sustainability

#5 Rebound Effects in the IST Context

#6 Integration and Interconnection in TERRA

#7 Resilience

#8 Poverty and Equity

#9 Human Capital

These Concept Sheets are extended definitions and discussions of key topics, outlining specific areas of knowledge necessary to the understanding of the processes and mechanisms discussed in the TERRA Insight Primers, which in turn support TERRA's policy briefing. Most of the material within them is derived directly from work in the TERRA project. Thanks are also due to contributors from outside TERRA, particularly Dr Venetia Evergetti of the University of Surrey (for research material from the ASSIST project) and Dr Francine Mestrum (for research material from the Aurelio Peccei lectures of the Club of Rome).

Citations in this copy of the concept sheets refer to entries in the main references section (starting on page 147).

# TERRA CONCEPT SHEET 1

## I.1 What is Sustainability?

In 1987, the United Nations identified sustainable development as a critical priority. This concentrated the world's attention on a set of related issues and problems, which had been recognised earlier, but in sporadic and specialised fashion. Put simply, the problem was that existing patterns of growth and development, while driven by apparently rational behaviour at individual, enterprise and even national level, produced aggregate effects that jeopardised not only the collective aspiration for adequate, equitable and fulfilling life for all, but even the very continuation of life on the planet. In order to deal with such a problem, it is necessary to recognise it at a collective level, to understand its dimensions and uncertainties, to identify the important actors and their motivations and powers, and to develop collective institutions (of whatever degree of formality) capable of supporting solutions.

The UN report identified three dimensions along which sustainability could be assessed: environmental (comprising resource use and ecological impact); economic (combining the provision and distribution of the means of sustaining life) and societal (including the institutions through which we interact with one another). Subsequent work has expanded this view (recognising in particular an additional, cultural dimension, to the dimensions of sustainability), and has greatly improved our scientific understanding of the mechanisms and processes involved, has generated masses of new data about the state and trajectory of world systems, and has produced a host of policy and institutional suggestions. Some have been tried out, and many more have been discussed. But the challenges of sustainability, far from receding, have sharpened and become more pressing. Moreover, despite the early and largely uncontested recognition that these problems (as a whole) are global in scope and require collective solution, increased awareness and knowledge have served more to exacerbate division and suspicion than to generate global consensus.

In addition to recognising the importance of the environmental, economic, societal and cultural dimensions of sustainability, it is increasingly recognised that these dimensions are important as a means of measuring sustainability and as a domain within which human institutions operate. The assessment of sustainability has also advanced; in the beginning, it was measured in terms of stocks of scarce resources, income, social capital, cultural products, etc. Despite early indications, however, we have not in general, run, out of these things. From this, we have learnt two lessons. First, human ingenuity can often identify substitutes for scarce resources. Second, from the human welfare perspective the ownership and distribution of resources matters as much as their absolute levels. This suggests that we should be concerned with the availability of world systems to support life – this is a more general and technology-friendly concept than a stock-based definition. Moreover, the past three decades have thrown up a number of shocks to the system. Some reflect unforeseen events, though most are the result of unanticipated spillovers from one sustainability domain to another or from responses to past changes. The conclusion here is that sustainability concepts and analyses based on availability need to be bolstered by

considerations of resilience to shocks, and that policies and plans need to be both robust and adaptive.

Overall, we are led to focus on what can be sustained, and what is needed to sustain it. To usefully implement such a definition, it is necessary to consider multi-dimensional outcome surfaces[171], develop interlinked representations of world systems, deal sensibly with risk and uncertainty, develop indicators that are connected to relevant decisions and consider ranges of preferences in a balanced, transparent and neutral way.

[171] In other words, to provide policy simulation/projection tools that take account of feedback to produce a view of the *set* of possibilities implied by current trends and developments.

## I.2 The Relationship of the Information Age to Sustainability

During broadly the same period, (post1983) that has brought Sustainable Development to the fore in the global political debate of, for example, the United Nations and the W.S.S.D., the world has seen the beginnings of a transition to a global networked knowledge society. The forces this transition has unleashed, combined with demographic, environmental, political and other changes, have raised awareness of issues of sustainable development in a very broad sense. The transition itself incorporates the continuing development and deployment of Information Society Technologies (ISTs), the increasing information-richness of economic, societal and cultural life (enabling both dematerialisation and immaterialisation), rapidly-changing patterns of communication, with consequent realignment of identities, allegiances and methods of working (networking), etc. These changes have potentially profound implications for sustainability.

The most obvious is this: the dilemma of sustainability arises because things are decided narrowly[172], which in reality have a rich network of global implications. The immediate implication of the global networked knowledge society is that the remote draws near, while that which was near may be crowded out (globalisation). This changes the shape of sustainability – it may lead to paradoxical conclusions, 'rewiring' the network of crosscutting effects and changing the identities, interests and powers of stakeholders. Networks also offer the characteristic of self-reinforcement, with each additional member providing extra value to each existing member, mixing the roles of consumers and suppliers in ways we do not always fully understand, but which seem to offer at least the possibility of benefits to sustainability.

The global networked knowledge society must, therefore, be understood and factored into our analysis of the world sustainability problematique. Available evidence shows that the transition has made some things worse: demand for goods and services produced from environmental resources has increased faster than the efficiency with which they are produced, transported, and used; differences in income are both widening and hardening into differences in wealth and differences in life chances, etc. At the same time, those same global networked knowledge society developments hold the promise – perhaps the only promise – of an escape from the dilemma of sustainability. New technologies may fulfil an expanding range of human needs whilst diminishing demands for resources; new means of access may reorient growth towards convergence without either loss of incentive or loss of diversity; and

172 This narrowness of perspective is temporal (failing to take account of long-run impacts), lateral (failing to consider external impacts on others and their reactions), regional (failing to consider other parts of the world in the same terms as we consider our own), dimensional (failing to take account of, e.g. the economic implications of environmental policy or vice versa) and cognitive (failing to take account of what we do not know as well as what we do know).

new means of communication may ultimately build an equitable, open and inclusive society that is both sustainable and sustaining.

# TERRA CONCEPT SHEET 3

## I.3 Globalisation and the Network Society

Globalisation

Globalisation, notwithstanding its ubiquity, remains an imprecise term. It is possible to see globalisation in (at least) two broad ways:

- as the emergence of a set of sequences and processes that are increasingly unhindered by territorial or jurisdictional barriers and that indeed enhance the spread of trans-border practices in economic, political, cultural and social domains, and

- (ii) as a discourse of political and economic knowledge offering one view of how to make the post-modern world manageable.

For many, globalisation as 'knowledge' constitutes a new reality and renders redundant the language and imagery of a state-centric world. This is not, it should be stressed, to describe or advocate the end of the 'nation-state' rather it is to identify the notion of globalisation as 'a normalising rationality of government, acting to limit what is possible and thinkable'.

Networking

Networking refers to the virtual and physical connections between people and/or between systems that enable communication (information exchange), considered in both quantitative and qualitative terms. Mere connectivity (the ability to transmit messages) is necessary but not sufficient for networking.

Networking has several concrete definitions. At one level, it refers to the 'reach' of potential connectivity: who can communicate, co-operate and interact with whom. At another level, it reflects the 'use' made of this potential: who communicates, what is communicated, and to whom. The former class of definition makes explicit reference to telecommunications and transport networks, compatibility standards, etc. The latter looks at how we interact and, in consequence, who we are. Globalisation is associated with the growth of networks of global reach and falling cost in many areas: collaborative research and innovation; production of goods and services; e-business and e-commerce; mobility and 'diasporas' of experts; advocacy, cultural exchange, etc. Within the economics community, a particular distinction is made between 'network effects' and 'network behaviour'. The network effects literature refers to strong complementarity among goods and services, which are thus thought of as part of systems. Competition among systems differs from competition among products: it rests on expectations about the future, co-ordination (network externalities) and compatibility. As a result, it can display excess inertia (and a bias

against progress); excess volatility (or negative and positive feedback effects), and winner-takes-all ('tipping equilibrium') behaviour. The network behaviour literature takes this one step further by examining how people are connected – the topology of networks. This literature looks at two general processes – how people choose behaviour in different networks (especially whether, when and how fast they will attain mutually-beneficial patterns and whether they will all behave in the same way) and the complementary question of which network links will be formed.

Information Society Technologies (ISTs)

These are the technologies for representing and transmitting information between humans; between humans and machines, and between machines. This is a vast topic, as communication is at the very heart of what it means to be human, what is a society, etc. Knowledge representation is one of the most complex theoretical fields of science: information representation, as a sub field of that, is a discipline of its own, but not one of particular concern for Terra. Some information economists claim that the only effect of ISTs has been to drastically reduce the cost and time of transmitting information. Wider viewpoints, dating particularly from McLuhan, include among the effects radical changes in the quality, quantity and meaning of what is being transmitted. Even more radical views (e.g. Stonier) would move information to a centrality comparable to that of fundamental particles. Whenever a situation offering the potential for such radical change has happened before, it has led to large-scale socio-economic discontinuities. The research to describe and interpret these past and current revolutions will continue for years, as Carlotta Perez, Manuel Castells and others have demonstrated. Exploring the broad implications of the IST revolution is an important topic for Terra.

The Information Economy covers ISTs and the automation of production processes (in the widest sense, including specifically issues of the production of services as well as material goods, and including also logistics) using computers. It thus includes the increasing information-content of goods, logistics, and services, and the resulting realignment of roles and responsibilities organised around easy access to masses of information.

The Information Society is 'powered' by the Information Economy, but involves rapid, broad and deep access to and exchange of information among all elements of society. Information Society communication channels are indicated in the following figure

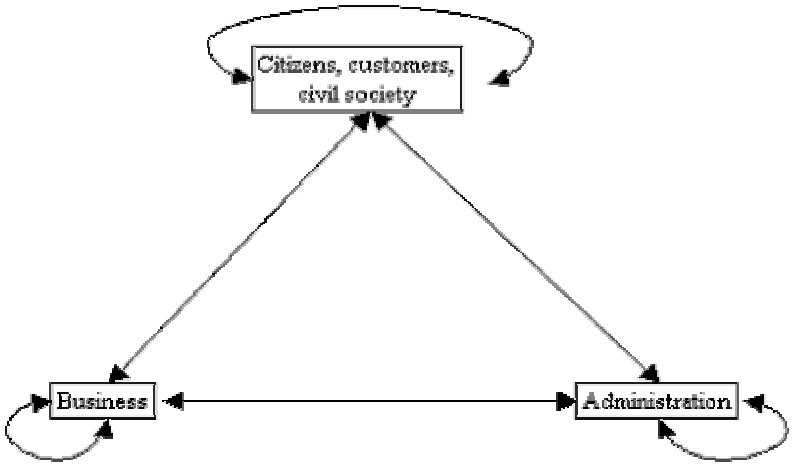



**Figure 17: Communication flows in the Information Society**

The emergence of an Information Society affects all communication loops shown (not just the 'economic' B2B, B2C and C2B ones) and thus further affects social systems operating in non-market or mixed domains such as health, education, welfare, governance, etc. In particular, the C2C, peer-to-peer interaction of citizens and the consequent issues of democratisation, inclusion and empowerment are generally identified as key political elements in the Information Society.

Knowledge Society

Information consists of structured and formatted data that remain passive and inert until used by those with the knowledge (see below) needed to interpret and process them. The cost of replicating information is the cost of making copies.

Knowledge (in any field) gives its possessors the capacity for intellectual or physical action - it is a matter of the cognitive capability to understand and use information, that is, to create meaning.

Knowledge is expensive to reproduce - cognitive capabilities are not all easy to articulate or transfer, and thus remain "tacit[173]." Tacit knowledge transmission depends on master-apprentice or collegial relationships, and thus on social ties, generational contact and the self-regulation of professional communities.

Some knowledge can be codified - reduced to information by increasingly complex actions (using natural language, applying industrial design techniques to make a blueprint, creating an expert system, etc.) Codified knowledge becomes (in its representation and sometimes even in its application) almost independent of human beings, and carries the implication that "the problem of memory ceases to dominate intellectual life[174]." This is broadly what Nonaka and others refer to as 'Explicit' knowledge. The interplay of information, tacit knowledge and explicit knowledge leads to the process of creation of new knowledge (new meanings for information) that we call 'innovation'.

[173] Term due to Polyani (1967).

[174] Goody (1977).

The Global Networked Knowledge Society (GNKS), seen as the successor to the Information Society, concerned with the acquisition, diffusion and application of new knowledge and thus with innovation. In fact, Castells thinks that the GNKS is characterised by its focus on how societies use knowledge to create new knowledge (not only ICT or computing). This, in his view, is a process that amplifies itself, and that is what makes it unique in the history of mankind. Needless to say, the GNKS is a controversial concept (see also Foray and David, 2001). The GNKS entails changed dynamics and responsibilities, and is thus challenged in finding a path to sustainable decision making, global governance, and preserving the capacity of our societies to adapt a changing human habitat (the planet). Seen in this way, GNKS and sustainable development are closely related and a key research topic.

TERRA CONCEPT SHEET 4

## I.4 Lifestyle, ISTs and Sustainability

Background

The concept of sustainable development has at its heart the consideration that many commonly accepted aspects of lifestyles in developed nations, are in fact not sustainable in the long run; constrained natural resources versus apparently unconstrained consumption or spoilage is not a contest that can be sustained for ever. The clear links between sustainability and human activity; and thus between sustainability and lifestyles, have been a common feature of the debate about sustainability (for instance in the context of environmental sustainability) since the 1970s (particularly in the shape of the I=PAT equation and its 'Indian Equivalents' interpretation[175].) and in more general terms have been visible since the days of Malthus. In the substantial literature on this topic, the unfolding story is that consumption (in the most general sense of the word) is an aspect of human behaviour, and thus that over-consumption may be seen as an aberrant behaviour. This view transcends the traditional consumption-production dichotomy and leads instead to a holistic approach to the problem in which we must face the reality that our difficulties arise as much from lack of *willingness* to deal with our over-consumption as from our lack of *ability* to do so. Such a view is clearly in line with the post-Kyoto understanding of the sustainability problematique. This behavioural approach immediately implicates lifestyle in both problem and solution; the IST-relevance of these arguments arises from the in-principle possibility of providing alternative (IST) satisfiers for non-material needs. Since material satisfiers are, it seems, little more than iconic or metaphoric satisfiers for such needs, IST satisfiers may even perhaps offer better substitutes from the lifestyle perspective. From such a standpoint, consumption is most readily treated as an aspect of human behaviour: much of the literature concerning it is accordingly based on a behavioural approach.

The Behavioural Approach

Brown and Cameron (2000)[176] are among those who utilise just such a behavioural approach in discussing problems associated with understanding over-consumption. They indicate that "reducing over-consumption will require strategies for changing consumeristic value orientations" believing that the roles of institutional structure and social values determine consumption behaviour. Within this framework, consumers' attitudes and values are shaped by the prevailing belief system of society. Aiming at

[175] This well-known equation was discussed in detail, and its limitations well described, in Commoner (1971), Chapters 8 and 9.

[176] Brown and Cameron (2000).

"higher-level changes", that is, at the socio-economic belief system and cultural values will therefore be most effective in reducing over-consumption, first to challenge the consumerist value orientation, and second to promote an alternative one. Princen (1999)[177] starts his argument by taking over-consumption as given and recognises that aggregate consumption together with technology and population is a major threat to the environment. The important question for Princen, is when does mis-consumption lead to over-consumption? In other words, "when is over-consumption not simply a problem of excessive throughput -that is a problem of too many people or too much economic activity- and when is it a question of the inability of individuals to meet their needs in a specific social context?" To talk about consumption levels and patterns "is to eschew the production perspective and to raise analytic questions that conventional analytic tools –price determination, cost-benefit analysis, even life cycle analysis- can not comfortably address" He points out that policy makers have to realise that they have to operate outside the dominant belief system, "to shift paradigms" and recognise that the problem cannot be solved with even more economic activity. After all, "most of us resist until change is unavoidable" Jackson and Marks (1999)[178] also question the conventional equation of increased economic consumption with human welfare and suggest "a conception of well-being in which human development is characterised in terms of fundamental human needs" Thus, their main question is whether there is a correlation between high GNP within a country and the level of welfare enjoyed by the people in that country. They take on Max-Neef's[179] view that although economic growth may increase human welfare; this is only up to a point. Beyond this threshold the environmental and social costs of growth are so high that it no longer contributes to human welfare.

Their message is that at the moment consumption patterns do not increase our human welfare, but that on the contrary they constrain and threaten it. Changing the way we satisfy our non-material needs is fundamental in helping the environment as well as increasing the potential of our future welfare. Work by Malaska et al at the FFRC has established a theory of welfare productivity, which is susceptible to quantitative analysis, allowing a more precise test of the principles of Jackson and Marks, which in turn seem to have developed from their earlier work on the ISEW[180] of Daley and Cobb.

### The Value-Change Approach

Within the framework of thinking that views consumption as an aspect of human behaviour, the link with values is clear. Inglehardt's value-change thesis (Abramson and Inglehart 1995[181]) assumes that "the economic security created by advanced industrial societies gradually changes the goal orientations of mass publics. In this process, an emphasis on economic security gradually fades, and universal but often latent needs for belonging, esteem, and the realization of the individual intellectual potential become increasingly prominent. Although individuals still value economic and physical security, they increasingly emphasise the need for freedom, self-expression, and improving the quality of their lives. Economic and security needs,

[177] Princen (1999).

[178] Jackson and Marks (1999).

[179] Max-Neef, Elizalde and Hopenhayn (1991).

[180] Jackson, Marks, *et. al.* (1998).

[181] Abramson and Inglehart (1995).

which they term 'Materialist' goals, are still valued, but they are no longer the top priority, for a growing segment of the public gives even higher priority to 'Postmaterialist' goals.

Value change is gradual, however, for people who grew up during periods of scarcity tend to retain materialist values. Those who grew up during the era of post war prosperity gradually replace older groups who experienced substantial deprivation during their formative years". A value-change approach is thus most likely to function over the time-scale appropriate to generational succession, at least in so far as the very large changes implicit in countering over-consumption are concerned.

Standard of Living vs. Quality of Life

At first glance there is an unbridgeable gulf between the neo-classical economics/GDP/Standard of Living syndrome and the sociological/ISEW/Quality of Life Approach to sustainability. Fine and Leopold (1993)[8] describe this gulf thus: *Neoclassical economics single-mindedly focuses on one essential principle – maximisation of utility subject to price and income restraints. Psychology rushes to the opposite extreme, embracing as many motivational factors (and constraints) as it can muster to explain the diversity of consumer behaviour.* A clue to the bridging of that gulf has recently come from Lane (2000)[9] who speaks of *'the wavering power of income to yield that ephemeral good, utility'*. Here the bridge between economics and the (other) social sciences is made by 'utility', the rational maximisation of which is central to economics but whose definition in developed economies proves to be dependant on soft-edged perceptions of components of Quality of Life such as happiness, family life, and place in the community: that is, to the broader components of Welfare and of Lifestyles.[10]

Conclusion

It is clear that the concept of 'lifestyle' embraces many considerations highly relevant to the reduction of material consumption. Dematerialisation of Production (eco-efficiency) is less an issue here than Immaterialisation of Consumption (virtualisation) – but both are implicated and indeed the concepts are intimately interconnected. A lifestyle approach embraces both: it necessarily raises issues of volition and of willingness to make the required adjustments, but nonetheless it offers cause for optimism where previously little existed. What have been described as 'nearby' IST substitutes for material consumption are clearly problematic, but broader-base 'lifestyle' substitution (syndromes of complex, interlinking changes which, in total, create a significant reduction in material consumption) seem more attainable.

The ASSIST research study (www.immaterialisation.org) developed this arrangement to identify a threefold contribution of ISTs to lifestyle change favouring sustainability. First, the background condition for change is aspiration for welfare gain, that is for Quality of Life enhancement; then there must be an inherent 'IST-pull', enhanced by

[8] Fine, B and Leopard, E. (1993) The World of Consumption Routledge London and New York

[9] Lane (2000).

[10] Current polemic views of lifestyle change are discussed in Flint and Houser (2001) This contains (amongst its hundreds of citations) the quotation 'Between 1990 and 1996, nearly 19% of adult Americans made a voluntary lifestyle change that entailed earning less money' Schor J. (1998).

the marketing of ISTs designed specifically for specific lifestyles; and finally there has to be a time lapse appropriate to generational succession, allowing those who have experienced IST-pervasive lifestyles in their formative years to come to maturity. There are many gaps of knowledge to be filled in this progression, but it does offer a rational schema for lifestyle change facilitated by ISTs and benefiting sustainability.

TERRA CONCEPT SHEET 5

## I.5 Rebound Effects in the IST Context

The Rebound Metaphor

Rebound is a metaphor frequently used in discussions about sustainability: a common use of the metaphor in this context would run thus:

"By more efficient design and production, a manufacturer of consumer products reduces material content per unit by 20%. This enables a reduction in retail price of 8% in a highly price sensitive market, in turn triggering a 19% increase in sales. There is thus a rebound effect that almost entirely counteracts the reduction in material use, since the net reduction for this manufacturer is now only 1%."

Many commentators imply that rebound effects will normally be smaller in magnitude than the trigger action; some argue that they are frequently greater. Saunders[182] has coined the term 'backfire' for this 'greater-than-100%' class of rebound, which avoids confusing the original metaphor: the point is that what is discussed is rendered the more easy to understand by the use of metaphor; provided that the material is sensibly used. (On the debit side, however, some interesting questions can easily be pushed aside by the strength of the metaphor: for instance, in the example above, does the sector as a whole, as opposed to the single manufacturer, now exhibit more or less material input?).

Rebound is such a strong metaphor, and its use is so prevalent, that in order to understand rebound effects in their technical sense and in the sustainable development context, it is first necessary to accommodate the real-world understanding of the metaphor.

*A Rebound is the countervailing effect of an action*. This is the metaphor of a bouncing ball, or of the rebounding punch bag. The core content of the metaphor is that there should be action in one direction; its reversal; and some link of causality between the two. To those with no specific interest in sustainable development this is the entirety of the metaphor's meaning.

The use of powerful metaphor has the advantage of easy ease of accessibility of a concept to a non-specialist audience: however, it also has the disadvantage that, once the metaphor is in general use, it is not easily possible to introduce new nuance of meaning into it, nor to bend the metaphor to a particular purpose.

This does not prevent further explanations of rebounds, nor does it preclude the categorisation of different types of rebound. (Indeed, three different types are

[182] Saunders (2000).

identified in the examples below). It does, however, militate strongly against over-extension of the metaphor.

## Limitations of the Metaphor

In the context of sustainable development the rebound metaphor has acquired, by habit of usage, some additional conceptual 'baggage' which has also to be acknowledged, but which is probably more harmful than beneficial This complication seems to have arisen from the routine imputation of a 'well-intentioned' standpoint when considering actions in the sustainability field. Given this imputation, then 'actions' will generally be assumed to be benign and 'rebounds' malign. Expanding beyond the original; simple, and accessible concept of rebound, it has thus become commonplace in work on Sustainable Development to discuss Rebound as any effect which tends to counteract some *desirable* feature of an action intended to further sustainability, adding a layer of subjective judgement (about intentions) to the original metaphor. To the non-expert reader there is, however, no such implication of desirable/undesirable or good/bad in the metaphor, only non-judgemental trajectories of action and reaction.

The addition of judgemental implications to the metaphor can lead to problems. Firstly, a judgemental understanding of Rebound can, unfortunately, become similar to the engineering concept of Murphy's Law (at its simplest Murphy's Law states that, if something can go wrong, it will). Murphy's Law of Sustainable Development would state that all well-intentioned actions are doomed to being overcome by rebound effects, thereby rendering all actions meaningless. Whilst entertaining, this has the unfortunate side-effect of conveniently justifying inaction and stasis among those individual, enterprises and nations with a predilection for inaction and stasis.

The second problem (specific to the discussion of ISTs and sustainability) is that it is far from clear that the initial socio-economic effects of the introduction of ISTs are necessarily beneficial. On the contrary, the initial action may never have been intended to be benign. In such cases it is quite likely to be the secondary effects that actually produce benefits. This cuts across the idea that secondary effects and/or ill effects are definitively Rebounds. In reality the process of introduction of a new technology delivers its benefits in a rather tortuous and often slow fashion, which may involve successive waves of benefits, and dis-benefits (perhaps overlapping) over long periods of time, and ISTs follow that general pattern. Equating initial actions with 'good' and rebounds with 'bad' simply fails to accord with observation of the nature of change in the Information Society.

## Backfire, Khazzoom-Brookes, and Despair

Some views of rebound are essentially of the Murphy's Law class. As a specific and highly reputable example, but only one of very many similar broad definitions of Rebound, the Finnish Society for Further Studies and the Finnish Association for the Club of Rome, in their publication 'On the Way to Sustainable Development' (1997) put it thus: 'Even if resource productivity were to advance by *dematerialisation,* the exploitation of natural resources and space will increase as a consequence of increasing consumption and population. There is, as yet, no solution to this *rebound effect.*' The definition of rebound implied by such a treatment is however very wide indeed. In particular, it is hard to see 'increasing population' as a rebound.

There is indeed a possibility that rebounds can overcome their original effect – cf the 'backfire' of Saunders above. Similarly, there are views of rebound in which it is used as shorthand for a sort of hand-wringing despair, that is, for the belief that rebound will always overcome its original effect. Perhaps somewhat unfairly this has become known as the 'Khazzoom-Brookes Postulate' following their work on the field of energy efficiency pricing and use. The Khazzoom-Brookes Postulate, that energy use increase always outpaces efficiency gains, seems to operate only up to a point: in fact total energy use in the most developed economies has in recent years reached a plateau not compatible with Khazzoom-Brookes Postulate, notwithstanding continuing progress in enhancing efficiency.

Examples of Rebounds

It is possible to suggest examples in which IST-led environmental impact reductions are subject to rebounds

a) Telework reduces travel energy use; but it also de-localises employment so that ten short local journeys in a week might be replaced by two longer journeys to see a more distant client or employer. That would represent a sort of 'process rebound', or 'general equilibrium effect'.

b) The introduction of web based booking systems for airlines (i.e. Ryan Air) can reduce the cost to the airline of a single booking by as much as 20 Euro. This is a significant contributor to 'own-price reduction' i.e. to the very low fares offered which have demonstrably expanded demand - this is Rebound-D, the characteristic rebound of dematerialisation, the 'direct rebound effect'.

c) The downloading of music, even if IPR rights are respected, reduces the amount that teenagers spend on music - clearly evidenced by industry sales figures. This does not lead to spending the saved money on more music, but rather contributes more generally to teenagers' spare wealth, to be wasted elsewhere. This is Rebound-I, the characteristic rebound of immaterialisation, or the 'indirect rebound effect'.

The terms 'general equilibrium effect', 'direct rebound effect', and 'Indirect rebound effect' are widely used in economic studies, e.g. Greene, Kahn and Gibson (1999). The terms Rebound-D and Rebound-I, corresponding to Dematerialisation and Immaterialisation, arise from Simmons (2002b). Rebound-D, or Direct Rebound, is an 'own-price substitution' effect. Rebound-I, or Indirect Rebound, is an 'income effect'.

Summary

Rebound is a strong and simple metaphor, but its very strength and simplicity militate against over-sophisticated usages. It is thus not possible to extend the metaphor of rebound beyond the simple understanding that rebound is the countervailing effect of an action without the real risk of losing the value of accessibility of the metaphor. In particular, imputations of what is desirable and what is undesirable are particularly difficult to apply to rebound, and serve only to confuse the picture when applied to ISTs. Specific instances of '100% plus' rebounds may be more usefully termed 'backfire' or placed under the banner of the Khazzoom-Brookes Postulate. It seems, however, to be well established that there are three significant

classes of Rebound: direct (Rebound-D); indirect (Rebound-I); and process (or general equilibrium).

## I.6 Integration and Interconnection in TERRA

The unfolding of the Global Networked Knowledge Society challenges assumptions about how policy levers work, what effects they produce and the roles of public, private and civil society stakeholders. This challenge applies particularly to the medium-to long-term unsustainability of a Global Networked Knowledge Society that seems increasingly dominated by short-term dynamics. Sustainability discussions and policies limited to one or two of its economic, social, environmental and cultural dimensions or to isolated parts of the GNKS cannot meet the challenge: sustainability is a global property of the whole system. This challenge calls for a holistic approach that nonetheless looks rigorously at specific aspects of the system; that combines quantitative and qualitative methods; deals with fairness as well as with efficiency, and that considers appropriate combinations of policy levers: joined-up thinking to find joined-up solutions. The Integration theme within TERRA takes up the specific issues, scenarios, models and insights from the Human Capital; Inequality and Growth, and Information Age Sustainability themes, and uses them to build an analysis that focuses on the system as a whole.

There are many relationships and tradeoffs, which play an important role in thematic analysis explaining interaction, enabling interpretation, or reducing complexity. For instance, it is generally believed that growth requires incentives, which in turn implies a need for inequality. However, this may only be locally true: economic growth is strengthened if potential customers can afford the goods and services on offer; costs associated with poverty and underdevelopment are reduced by fair allocation; efficiency is strengthened by fair competition, which means strong competitors on a world-wide scale, etc. Also, while greater rewards for efforts, initiative or well thought-out risk taking are necessary incentives, there is no reason why they should be disproportionate or should persist into advantages for successive work, initiatives or generations. The trade-offs implicit at a thematic level may thus need to be reinterpreted or even abandoned in integration.

As a further example of relationships which may apply locally but not globally, it is increasingly observed that growth in general, and economic development in particular, place increasing demands on both input and ecological resources. While the relationship between environment and income in cross-sectional data is in general an inverted U-shape (the environmental Kuznets curve), this need not be true of the developmental trajectories of individual countries and there are some significant exceptions to the relationship. Fundamentally, technology and economic growth constitute a two edged sword, capable both of doing and undoing damage to environmental quality, and the integrative approach offers some hope of understanding how to decouple growth from pollution or even to re-couple them into a beneficial relationship. ISTs and networking are critical to this transformation: they support the mechanisms that allow us to internalise the external costs generated by our activities and support collective mechanisms (e.g. markets) for reallocating activity and deploying solutions. At a more immediate level, advances in

communications allow us to change patterns of work, commerce and energy use; these have clear implications cutting across all three of TERRA's major themes.

TERRA CONCEPT SHEET 7

## I.7 Resilience

1. Shocks and sustainability

For better or worse, the world we inhabit is affected by unforeseen (and often unforeseeable) events. Some of these come from inside the economic system itself, others are exogenous. Some can be 'headed off' or controlled by appropriate hedging or buffering – but this in turn depends on the ability of those who could take these actions to recognise and plan for unforeseen contingencies. These reactions become part of the behaviour of the system, and should be taken into account when assessing sustainability in terms of *resilience*. In other words, both the ability of the system to continue to sustain life (and its desirable characteristics) and the ability of the system to respond to shocks are appropriate measures of sustainability.

Nowhere is this self-governing or self-aware aspect more evident than in the economic system. The very word economics derives from the Greek word for the household, and the essence of economics is the sustaining of life within external constraints. At best, the economy is a means to an end, and that end is the sustainability of fulfilling human life.

2. Resilience

Two rather different concerns dominate analysis of the environmental consequences of economic change. As described by Perrings (1998), the concern that desirable states or processes may not be 'sustainable' is balanced by the concern that individuals and societies may get 'locked-in' to undesirable states or processes. Both concerns reflect a perception that there are many possible states of the economy and its environment, and that not all states are equally valued or equally persistent.

Collaborative work between ecologists and economists has used the ecological concept of resilience to explore the relative persistence of different states of nature. The concept of resilience has two main variants. One concerns the time taken for a disturbed system to return to some initial state and is due to Pimm (1984). A second concerns the magnitude of disturbance that can be absorbed before a system flips from one state to another and is due to Holling (1973). Both variants deal with aspects of the stability of system equilibria, offering alternative measures of the capacity of a system to retain productivity following disturbance.

Most work in the area concentrates on the Holling version and its application to managing joint economy-environment systems. But given the interest in lock-in and sustainability, both have a rather natural appeal. In particular, the nature of 'network externalities' and the value of connectedness and compatibility mean that the possibility of sub-optimal equilibria reflecting co-ordination failure is pervasive.

## 3. Near-Equilibrium States

The concept of resilience provides a different perspective on economic dynamics from that normally adopted by economists, and a different set of insights into the way economic interactions with the environment drive changes in the joint system. Instead of focusing on the system equilibria and the properties of the system at equilibrium it focuses on the basins of attraction around those equilibria, and the susceptibility of the joint system to change at different points in the basin. Indeed, one element in the path dependence of the joint system is precisely that its sensitivity to shocks varies as it converges on the equilibrium state.

Economists have generally tended to equate sustainability with both equilibrium and the steady state (cf Baldwin 1995). The sustainability of extraction or investment paths, for example, tends to be evaluated as a property of the system at long-run equilibrium, usually in a deterministic framework. Levin et al. (1998) suggest that sustainability is more an issue in stochastic than in deterministic systems, and that it is best measured by system resilience whether at or away from equilibrium. In an evolutionary system this makes resilience both more policy relevant and more testable. To be sure, it is just as difficult to devise appropriate experiments in economics as it is in ecology, but the adaptive strategies or policies devised to test (and manage) the resilience of complex path-dependent ecosystems (Walters 1997) apply, a fortiori, to economic systems (Anderson et al. 1988; Arthur 1992).

Economic development and environmental change are stochastic evolutionary processes. Analysis, measurement and management of those processes require an appropriate set of concepts and tools. The concepts and tools developed by ecologists to deal with the evolution of multiple equilibrium ecosystems have the potential to change fundamentally the way we approach the economics of change. Recent work on the evolution of networks and of behaviour among networked individuals reinforces this thrust. As shown in Cave (2002), many of the features of GNKS labour markets (and other economic interactions at the micro and meso level) exhibit the characteristics of co-ordination games. Thus the same tools applicable to the analysis of economic-environmental systems at the macro level can be applied at the micro and meso levels. There, they can be used to relate the concepts of resilience and equilibrium to such network properties as power-law distributions, path lengths (small worlds) and clustering.

## 4. Is the world becoming more volatile?

The 'insulation' of 'real' and 'financial' systems from each other is clearly breaking down as a result both of volatility and of the increasing participation in financial markets by a whole range of new and relatively naive actors for instance via ISTs permitting real-time information tracking, sophisticated asset valuation models (and derivative assets) driven by huge amounts of data, off-floor trading, etc.

The volatility of markets is increasing in ways that can be traced to the spread of common models (a network externality); globalisation of markets; securitisation of assets that were once non-traded (like sovereign debt) but have real implications (e.g. for public spending); and cross linkage of markets (e.g. oil prices, Russian debt, Mexican investment, US banks and pension funds).

Volatility is further enhanced by speculative bubbles (like IT/telecom, etc.). Again, these often have real implications for sectoral stability, income distribution and intergenerational equity.

Clearly, as more and more information becomes available, the *quality, distribution* and *responsiveness* of this information become crucial. More isn't better, aggregate measures are not meaningful, markets don't efficiently combine or average information, information becomes obsolete very fast, etc. As a result, the assumed relationships between data, information, knowledge, belief and truth are shifting. What remains, however, is a tendency to be attracted to a limited range of near-equilibrium states, whose degree of resilience against shock is a vital component of sustainability.

TERRA CONCEPT SHEET 8

## I.8 Poverty and Inequality

Introduction

On the face of it, poverty is a well-established concept. The firm societal belief that it constitutes an absolute ill has subsisted for some thousands of years, albeit with some dissent from religions and ascetic commentators espousing the virtues of particular types of material deprivation.

However, this gut-feeling that poverty is wrong is not easy to translate into precise definition. Absolutes of famine and starvation in the least developed nations are in consequence to be found under the same poverty umbrella as fine relativities of deprivation in wealthy developed nations. Extremes of (e.g. income) inequality have similarly been seen as being clearly a wrong – but without any consensual understanding of what represents a desirable level of income (or opportunity) inequality, although there is a long history of (again, instinctive) belief that absolute equality is also not desirable.

Recent work has attempted to create a more 'rational' understanding – that is to say, an understanding that would allow actions to be taken with confidence that their effects would be beneficial. This has proved less easy, and less readily consensual, than might have been expected. The current outcomes, described below, are still subject to the strong criticism that they tend to track the dominant global political paradigm of their day, rather than representing any larger truth. However, poverty and inequality are contained within what is generally taken to be the sphere of political action, so it may be argued that a politically-derived outcome was only to be expected.

Understanding Poverty – income data

The Rio Summit on Environment and Development in 1992 was the first of an impressive series of major UN Conferences that shaped the new international development agenda at the end of the 20th century. 'Combating Poverty' was one of the first chapters of Rio's Agenda 21 (AG21). This focus on poverty is a remarkable new feature of the development discourse of the international organisations. Of these the World Bank is clearly among those for whom 'Combating Poverty' is most relevant. When the World Bank published its first World Development Report on poverty, it had very few reliable and comparable data. It should be emphasized that *the emerging international poverty discourse of 1990 had no real empirical foundation* (Tabatabai, 1996). For this reason, inter alia, the international poverty line used by the World Bank is highly controversial. Very different outcomes result from looking at national poverty lines or from looking at relative instead of absolute poverty. The methodology used by the World Bank and its subsequent modifications has also been subjected to severe criticism (Reddy & Pogge, 2002). UNCTAD

recently published its own poverty assessments for the least developed countries and arrived at far less positive results (UNCTAD, 2002: 111).

## Understanding Poverty – non-income based views

Poverty is frequently said to be a multidimensional problem in which income and consumption cannot be the only criteria to be taken into account. The UNDP has devised a *human development* index, combining income, education and life expectancy, and a *human poverty* index combining health and education data, without income. Notwithstanding the improvements of its empirical database, the World Bank focuses more and more on the non-monetary aspects of poverty. It now does not even use the traditional social indicators but – following its wide-ranging participatory poverty assessment - *defines poverty in terms of vulnerability, voicelessness and powerlessness* (World Bank, 2001). According to the UNDP, it was a diagnostic error to think of poverty reduction in terms of social protection and social expenditure (PNUD, 2000: 8, 42). It also has to be pointed out that the World Bank, following its reconceptualisation of poverty, now focuses its strategy on empowerment, opportunity and security. The income dimension is almost totally absent from all currently proposed strategies.

## The WSSD Debate

A totally new class of agreement at the 2002 World Summit on Sustainable Development in Johannesburg was the establishment of a World Solidarity Fund, to be financed with voluntary contributions, while '*encouraging the role of the private sector and individual citizens*'. This supplanted the previous 20/20 pact (for allocating 20 % of ODA and 20 % of national budgets, respectively, to basic social programmes) which had been formally launched in Copenhagen in 1995; repeated in the Report of the Secretary-General, and approved at the Rio + 5 Special Session of the General Assembly. In consequence, the chapter on poverty and other poverty-related elements at Johannesburg was less strongly worded and less clear than AG21. This is surprising, since Rio + 10 adopted the title of the World Summit on Social Development (WSSD), which encouraged hope for a stronger focus on the social dimension of sustainable development. In fact, Johannesburg produced no clear-cut concept of poverty and gave no assessment of the recent trends in world poverty. In the context of the overall negotiations and apart from the one paragraph on the World Solidarity Fund, it seems as though most participants take poverty alleviation as an obvious and uncontroversial objective. The World Solidarity Fund is the only new element, but it gives rise to considerable doubt, since there certainly is no shortage of adequate institutions at the global level. The risk of overlapping with UNDP or other organisations is not impossible, while the 'voluntary contributions' from the private sector constitute an additional shift from structural social development towards charity.

## Poverty and Sustainability

The question concerning the links between sustainable development and poverty eradication follows from the ambivalent and frequent references to poverty eradication as '*an overarching objective*' of sustainable development – that is the desirable *outcome* of a successful development process – and '*an essential requirement*' for sustainable development – that is a *means to and end*

(Johannesburg Political Declaration § 11). This matter has to be seen in the broader context of poverty eradication as related to development in general. It has to be taken into account in order to understand the enthusiasm with which the 'sustainable development' project of the Brundtland Commission was met (World Commission, 1987). Not only did this allow for a 'greening' of development, by integrating the ecological dimension, but it also offered new hope for a new and broader development paradigm, away from the exclusive economic focus and away from the deflationary "Washington Consensus" of the World Bank; I.M.F., and White House.

Focusing on poverty as the *independent* or as the *dependent* variable of development is a choice with consequences for the shaping of social and environmental policies. If poverty eradication is seen as the *outcome of* a sustainable development process, then it seems logical to focus on the preservation of natural resources, as well as on their equitable distribution. In that case, anti-poverty policies might focus on human rights, inequality and the unsustainable consumption patterns of the wealthy. Yet, if poverty eradication is seen as a *mechanism* of sustainable development, then everything should be done to limit the damage caused by poor people. Policies to stop population growth are the first logical element of such an approach, whilst giving poor people access to productive resources that are less harmful for the environment comes next. In the Johannesburg process, poverty eradication is by no means exclusively linked to environmental decline. '*The ever increasing gap between the developed and the developing world pose a major threat to global prosperity, security and stability*' (Johannesburg Political Declaration §12). '*... the poor of the world may lose confidence in their representatives and the democratic systems to which we remain committed*' (§ 15). These ideas are also put forward in the multistakeholders dialogue (United Nations, 2002b: 25): '*poverty alleviation and economic stability are crucial for environmental and social sustainability'.* Sustainability, then, acquires a broader meaning as it is linked to social and economic stability.

The 2003 World Development Report (World Bank, 2003) elaborates on a concept of sustainability that now refers to the utilization rate of the resource base of development, be it in social, environmental or economic terms. Poverty alleviation, then, belongs to the social pillar of sustainability and is linked to '*social stress – and, at the extreme, social conflict*'. It refers to the Bank's concept of social capital, as part of the capital *stock* needed for improved productivity and growth (World Bank, 2002; Serageldin & Grootaert, 2000). In its renewed institutional approach relational and natural assets are both part of the '*broader portfolio*' to be managed by governments. '*For the assets most at risk – the natural and the social – markets cannot provide the basic coordination function of sensing problems, balancing interests, and executing policies and solutions'* (World Bank, 2003: 184). In this approach both the environment and poverty eradication ('*and other forms of conflict prevention*') are inputs into a sustained growth process needed for enhancing well-being through time. Thirty years after the first report of the Club of Rome calling for 'limits to Growth' (Meadows et al., 1972) in order to protect the environment, we have now come full circle: environment protection is said to be needed in order to preserve the growth process. The focus on poverty reduction in developing countries allows for emphasis on the need for more growth in the absence of redistributive policies. At the same time it contributes to alleviating the pressure on developed countries to change their unsustainable production and consumption patterns. It helps to explain the growing conceptual convergence of sustainability, poverty reduction and conflict prevention.

## Work as a Cure for Poverty

In the new perspective of poverty and income inequality, work is seen as a panacea. In a properly functioning market, those who work cannot be in poverty, which becomes a symptom only of local market failure. From a sociological perspective, Bauman (1998) has looked at the issue of how poverty and the poor are defined in our society, and treated by society in general. He begins his discussion by historically exploring the work ethic's two major purposes: firstly, to solve the problem of labour supply for the newly expanding burgeoning industries; and secondly to deal with poverty by forcing poor people to join the workforce. According to Bauman the goals of the work ethic were met so successfully that 'work occupied the focal position on all three analytically distinguishable levels of modern arrangement – individual, social and systematic'. He argues, that in the beginning the capital-labour struggle focused on preserving the workers' autonomy, later it moved to a different concern of maximising their share of the surplus. From a society based on the work ethic we have moved to one based on the ethic of consumption. In such a society, Bauman argues there are still producers and the production force is very important, but the individual is first and foremost characterised as a consumer. What is interesting about this development is that new definitions of poverty are invoked, so that a new form of poverty has risen, associated with incomplete consumerism.

With poverty reduction reconceptualised in this way, the idea of social development becomes eroded. If free market forces have to be respected, then income guarantees and protective measures are to be banned. They may benefit some groups but they are now said to be detrimental to the poor, either because they do not reach them, or because they distort the markets. Social security systems are now said to be inadequate for reducing poverty (PNUD, 1991: 55, PNUD, 2000: 42-44).

The rationale for the new social protection policies promoted by the World Bank is based on the notion of risk. If the laws of nature and of economics cannot be changed, human societies will always remain vulnerable, though they do have the possibility - and the obligation – to protect themselves. Social protection, then, becomes an element of risk management, whether these risks are related to natural phenomena or to human action. Risk management is necessary in order to cope with earthquakes, the volatility of financial markets, unemployment or illness. These risks are the same for all people, though the poor are the most vulnerable. Therefore, governments have three options for their social protection policies. Ideally, risk prevention would be desirable, but '*we know*' that this is not possible at a reasonable cost or without harming growth. All governments can do is to have sound macro-economic policies and to create enabling environments. Risk mitigation is the second option and aims at alleviating the negative consequences of possible future '*shocks*'. It can imply the broadening of people's assets by enhancing their human and social capital. The third option is a set of '*coping mechanisms*', once risk has materialized (Holzmann & Jørgensen, 2000).

## Conclusions

The poverty reduction strategies that are now being promoted place the responsibility of income generation again upon the poor themselves, which helps to explain why the income dimension is absent from poverty reduction strategies. Provided that there exists *access* to work, to education etc, then poverty cannot exist. Intellectually attractive as these arguments may be, at least to some, it is all

too clear that concepts of poverty change over time in accordance with the dominant political paradigm of the day. Whilst this reflects the realities of practical politics, it also casts doubt on the idea that poverty is a clearly defined condition, and leaves issues of income inequality totally unresolved.

TERRA CONCEPT SHEET 9

## I.9 Human Capital - ICT, Skills and Creativity

Introduction

A range of authors and authorities has asserted the capacity of ICT to transform the demand for and usage of skills in the workplace[183]. Not unsurprisingly, this vision has proved an attractive one for policy makers, not least because it chimes well with a widely-held belief that global economic forces are compelling developed economies to follow a high value-added, high skill route and that unskilled work is rapidly vanishing[184]. The result in some states has been a massive investment of time, political capital and public money in a rapid expansion of the education and training system to provide the highly skilled and qualified workforce that it is now assumed the economy will require[185].

ICT, Creativity and Work Organisation

The importance of using PCs or other types of computerised equipment for most occupational categories rose quite sharply between 1997 and 2001. For example, in the U.K. '2nd Skills Survey', only 37.8 per cent of managers reported PC usage as essential to their job in 1997, whereas by 2001 the percentage had risen to 52.6. Overall 51.7 per cent of respondents believed that the importance of ICT skills in their job had increased in the last five years. Moreover, from a range of 36 generic skills, 'using a computer, PC, or other types of computerised equipment' was one of the few for which the 2nd Skills Survey was able to detect there being a positive wage premium[186]. However, there are some significant problems. Levels of apparent over-qualification are rising. Overall, 37 per cent of respondents appeared to hold qualifications at levels higher than those needed to obtain their current employment. At the bottom of the labour market, there are now only about 2.9 million economically active people aged 20-60 in the U.K. who possess no qualifications, but about 6.5 million jobs for which no qualifications would be required to obtain them.

The Workplace Employee Relations Survey (WERS) shows that there continue to be many highly routine, low-skilled jobs offering very limited opportunities for creativity, trust or discretion[187].

[183] Leadbetter (1999).

[184] Reich (1983).

[185] Wolf (2000).

[186] Felstead, *et. al.* (2002).

[187] Cully, *et. al.* (1999).

The work of Gordon (1996) and Cappelli et. al. (1997) indicates that a similar picture on work organisation and employee relations systems is emerging in the USA. As Milkman (1998) observes, "the low-wage, low-trust, low-skill 'low road' is the path most US firms are following".

## ICT – Dependent or Determining Factor?

Some of the more evangelical literature on ICT assumes that the technology has a transformatory capacity. However much of the research on the impact of technology (of all kinds) on work and work organisation refutes simple technological determinism and indicates that, "technology is always a tool and never an independent cause of human arrangements[188]". The danger is that rather than deploy ICT in potentially emancipatory ways, many organisations will use it to do more of the same, harder. This can lead to low trust work organisation. Indeed, as Bjorkman (2002) points out, aspects of Taylorism and scientific management form an integral component of many new business management tools and technologies, such as Total Quality Management (TQM), Business Process Reengineering (BPR), and Just-In-Time production (JIT). The 'iron cage' of rational bureaucracy has thus, in some cases at least, been given new and stronger bars.

## The Dominant Influence of Brands

The final reason why ICT may be having a more limited impact on skill profiles than expected concerns the way that organisations choose and formulate their competitive and product market strategies. In making these choices, organisations are confronted with a wide range of models of competitive advantage, by no means all of which are chiefly dependent upon a more creative or autonomous workforce, or upon generally higher levels of employee skill[189]. Much of the literature on marketing makes clear the importance to competitive and product market strategies of creating and sustaining successful brands[190]. One of the effects of successful brands is that they allow firms to charge a premium for products that may lack any tangible quality or specification advantage over competing products. Many highly successful global brands do not require the bulk of the workforce delivering them to be particularly highly skilled or to be managed in ways that allow for high levels of creativity and autonomy – for example Coca Cola, Nike, and McDonalds.

How do these choices affect skills? One useful pointer to this is the literature on core organisational competences, sometimes also referred to as the resource-based view of the firm. Boiled down, this literature argues that what makes an organisation successful are a set of unique capabilities that allows it to pursue its competitive and product market strategies differently from and better than its competitors[191]. While the concept of core organisational competences is not without its drawbacks as an analytical tool, it does indicate the importance of considering the location and distribution of these key skills within the organisation. Put simply, in some organisations the skills that really make a difference may be widely distributed across

[188] Levett (2000).

[189] Pettigrew *et. al.* (2002).

[190] Doyle (2000).

[191] Prahalad and Hamel (1990).

the workforce, while in others they may be concentrated in a tiny sub-section of the employees.

Many service sector organisations, located in multiple retailing, retail warehousing (for example, DIY stores), insurance, and banking, appear to be closer to the concentrated end of the spectrum of distribution for core competences.

Conclusions

The chief conclusion that can be drawn from the foregoing is that if a high-wage, knowledge-driven economy where workers can deploy high levels of skill and creativity in more autonomous work settings is the desired goal for policy makers, new forms of intervention may be required.

In part this new perspective reflects a realisation of the potential dangers raised by too patchy or halting an adoption of the new models of workplace organisation and economic competitiveness. Current policies require significant investments, by the state and increasingly by individuals, in higher levels of qualification. Of particular note is the U.K.'s target of 50 per cent participation in higher education by the 18-30 age cohort. If the knowledge and skills being created by ever more extended periods of initial education and training are not used productively, the risk must be that both the public and private rates of return on the investment will be sub-optimal. This problem is heightened by the knowledge that skills that are not used are often prone to loss due to atrophy [192]

There is also the danger that people trapped in jobs that do not make the full use of their skills are liable to become discontented and less committed to their work and to their employer[193]. It is therefore the possibility that one outcome of supplying a workforce potentially over-qualified for many of the narrowly-designed jobs available is that, far from boosting productivity, it may actually create the conditions in which productivity can either decline or plateau.

If simply supplying more skills is not sufficient, what more needs to be done? A range of different types of policy intervention at national, regional, local, sectoral and supply chain levels may be required. These include business support aimed at helping organisations shift their product market strategies towards high value added and the adoption of models of HPWO; the use of public purchasing policy to encourage these developments, attempts to foster a better quality of working life, lined to the need for better and more innovative work organisation and job design; encouragement of and support for industry clusters and supply chains to shift product market strategies upwards and encourage the spread of HPWO; the use of the public sector as an exemplar of good practice, not least in terms of using ICT to support more empowering forms of work organisation and management; encouraging better educated and more demanding consumers; and closing off routes to cost-based competition, for example through higher minimum wages. This is, a long-term agenda, one that would require at least a decade to make significant headway.

[192] Krahn (1997).

[193] Felstead, *et. al.* (2002).

# II Appendix II: Insight Primers

## TERRA INSIGHT PRIMERS

### II.0 Contents

## II.1 ISTs and Reducing Environmental Impacts

'Here with a loaf of bread beneath the bough,
A flask of wine, a book of verse – and thou
Beside me singing in the Wilderness –
And Wilderness is Paradise enow.'

'*The Rubaiyat of Omar Khayyam'*
*Translated by Edward Fitzgerald.*

Introduction

This Insight Primer discusses the mechanisms by which the various propositions relating to ISTs and Environmental Sustainability may be tested and operationalised. These 'sub-propositions' are as follows:

### Environmental sustainability propositions

The concept of sustainable development has at its heart the consideration that many commonly accepted aspects of lifestyles in developed nations, are in fact not sustainable in the long run; constrained natural resources versus apparently unconstrained consumption or spoilage is not a contest that can be sustained for ever. For the purposes of TERRA it is not necessary to define or delineate the extent of the unsustainability with great precision: it is enough to be aware of the risk and to observe that much statistical data exists to evidence its reality[194]. Sustainable lifestyles are those that consume less material resources; consumption in this context includes spoilation, waste and pollution.

Emergent technologies based on information (from ICTs to bioengineering) can help to dematerialise production and distribution of goods and services by reducing associated material inputs and waste outputs.

Both dematerialisation and immaterialisation reduce the opportunity cost (price) of material inputs and environmental sinks and increase the welfare content (and even the levels) of income and wealth. The change in relative prices can induce substitution of material for immaterial inputs. The increase in purchasing power can stimulate consumption of both material and immaterial goods and services. These substitution and income effects can outweigh the benefits of the original changes.

[194] Some commentators (e.g. Lomberg (2001)), dismiss the risks as smaller and more distant than the norm - and nonetheless admit that risks exist but assume that preventative measures will be taken. The ASSIST work is not in any way incompatible with that viewpoint.

There has been for many years a well-established field of study, and increasingly a real and useable knowledge base, in the area of 'dematerialisation' or 'eco design' or 'eco-efficiency', where ISTs also have a part to play in the progressive reduction in the material content of goods and services. By aiding better design, and by facilitating more efficient use, ISTs have already contributed significantly to Dematerialisation.

Immaterialisation is characterised by a 'switch' in consumption behaviour from more material to less material.

*Immaterialisation consists of switching from physically based clusters of satisfiers for human needs and wants, to alternative clusters of satisfiers for those same needs and wants, which vastly reduce the material element of the consumption involved.*

Immaterialisation is thus a switch: it is quite distinct from the process of progressive dematerialisation (or increasing eco-efficiency). One specific class of immaterialisation is that in which IST lies at the heart of the substituted cluster of satisfiers.

Rather obviously, IST based clusters of satisfiers will not totally eradicate material consumption, although in general they will reduce it very greatly. Additionally, it will generally be the case that the substituted cluster of satisfiers will itself be subject to progressive dematerialisation (that is after the switch of immaterialisation) and that this subsequent dematerialisation will proceed at a faster rate.

The Rebound Effect does not manifest itself in the same form in the context of immaterialisation (Rebound-I) as in the context of dematerialisation processes (Rebound-D). *When the immaterialisation switch takes place, the satisfaction of needs and wants at a reduced material cost will release spending power, which will then become available for the whole totality of all goods and services. This is Rebound-I.* This may or may not threaten sustainability, in the same way as does all expenditure generally. It will not necessarily or specifically generate any additional consumption of the same IST cluster of satisfiers. It will, however, contribute to growth, being an instance of the creation of surplus.

Lifestyle change is an example of value-led behaviour change, which is much influenced by the lifestyle, experienced in early, formative, years (particularly the teenage years) and is in consequence a very long term issue. The direct substitution approach is problematic because of the generally indirect and/or complex nature of substitutions observed in practice. A virtual or immaterial substitute may satisfy some of the complex needs satisfied by its material predecessor - but in general it will also fail to satisfy others and will also satisfy some needs not addressed by its predecessor.

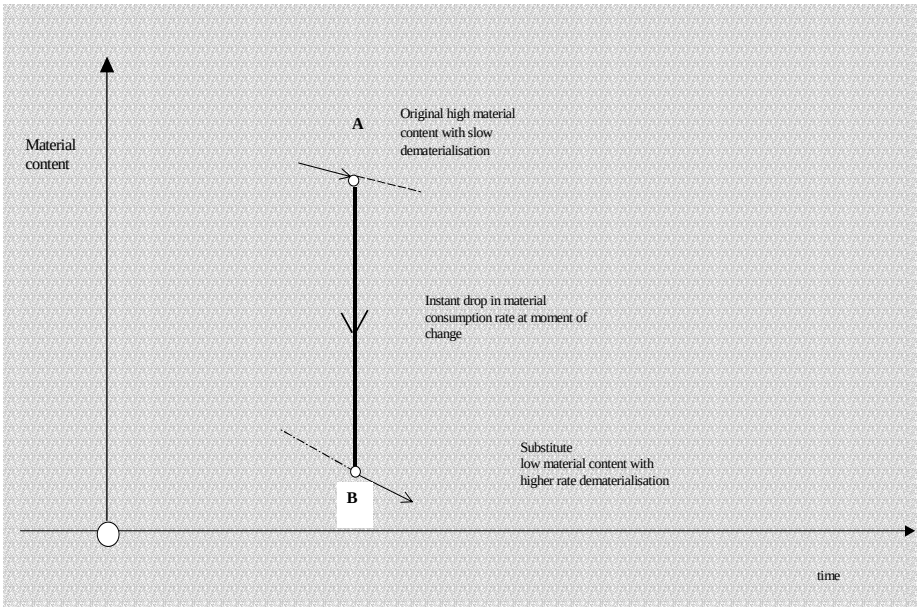



**Figure 18: The Immaterialisation Switch**

The figure shows the switch of immaterialisation as a shift from one trajectory of dematerialisation to another trajectory which is both at a much lower base level of material use (being IST based) and is also dematerialising more rapidly (as is characteristic of ISTs). Although purely illustrative, the figure does allow the identification of the key areas of analysis.

Point A on the diagram is the point at which the decision is made to switch to an immaterialised solution (by means of an IST-mediated lifestyle change). Key issues here are perceptions of quality of life enhancement; IST-attractiveness; and generational replacement.

The line A-B is the switch itself. Here the issues are concerned with the modalities - what are the future IST-mediated lifestyles offering the best practical promise of substantial immaterialisation? LCA-I is offered as an analysis tool here.

Finally point B is the situation post switching. Issues arising here are the outcomes of the Rebound Effect (Rebound I); and the subsequent rate of further dematerialisation.

Immaterialisation is a major change, within which a particular want is met by an immaterialised cluster that costs much less than the material alternative. The consumer can buy all he wants and still has money left over to buy other things. Thus the income effect dominates the price effect. In contrast dematerialisation is a marginal change (in eco-efficiency) resulting in a relatively small drop in price, which encourages more expenditure on the dematerialised item. In this case, the price effect dominates.

Together all these factors identify the total contribution to sustainability.

The Total Environmental Stress approach to sustainable development[195] is quite uncompromising in its statement that sustainable development cannot advance unless welfare advances or at least does not decline. Many other approaches to sustainability take the same stance: indeed, it is possible to interpret the word 'development' in precisely this way (i.e. as an advance in total welfare). Some radical activists (e.g. in the anti-globalisation movement) dispute this view and see the equitable *balance* of welfare (between and within societies) as the essential test. Common to both standpoints is that welfare (rather broadly defined) is, at the least, intimately bound up with sustainable development. Self-interest is also intimately concerned with welfare; that is to say, with issues of perceived quality of life. (This has to be clearly distinguished from standard of living: the deficiencies of GDP as a measure of welfare are commonly accepted, but there is no single strong contender for the measurement of either welfare or quality of life. ISEW[196] and HDI, for example, are strong indicators but have significantly different intentions). The first major factor identified as central to lifestyle change is thus welfare advance, in the sense of enhancement of perceived quality of life. This is a more subjective measure than standard of living: it is clear that perceptions of enhancement will vary very greatly according to the circumstances of the perceiver, particularly where large variations in per capita GDP apply. Quality of Life Enhancement at 250 Euro p.a. is quite different from that at 2500 Euro p.a. which in turn is quite different from that at 25000 Euro p.a.

For ISTs to contribute to the maximum to sustainable development, it is clearly necessary that there should be ubiquitous take-up of ISTs. This self-evident truth invites the question - how will this be achieved? It is rather implausible that people as a whole, across the globe, should be somehow forced or regulated into IST use: clearly the take-up must be voluntary - IST-pull rather than regulatory-push. Regulation may well be needed to enable access, but it cannot force individuals to use that access. Similarly commercial influence seems likely to prove a more substantial influence than individual altruism. Both regulation and the effects of altruism (a genuinely strong potential effect) apply more readily to the narrower focus of Dematerialisation of production (recycling would be a typical example of this). On a wider scale, significant changes in lifestyle generally seem to be beyond the scope of altruism to achieve (for most, but not all, people) and also of regulation (for most, but not all, governments), but in general they do not seem to be beyond the scope of marketing. IST pull must therefore rely on the perception of the consumer that the new, more mature, ISTs advance their perceived self-interest personally or within their immediate surroundings - family, workgroups etc. In addition to the intrinsic merits demanded of ISTs, the making visible/explicit of these perceived benefits is likely to be crucially dependant on marketing and probably (given the high immaterial content of brands) on brand marketing. The second major factor identified as central to lifestyle change is thus IST-attractiveness, mediated by marketing. This may be encouraged by governments through the medium of funded RTD, and facilitated by discriminatory taxation or by regulation (e.g. universal service provision), but ultimately IST-pull and marketing will be the dominant issues.

Consumption patterns arise from the values and preferences of individuals. IST-pull addresses the issue of preferences. There is a well-evidenced case that 'long-term

[195] Malaska (1996) op. cit.

[196] A good explanation of ISEW in this context is Daly and Cobb (1994).

value change results from generational replacement'.[197] It seems reasonable to deduce, therefore, that long-term lifestyle change will exhibit the same characteristic dependence on generational succession.

This goes beyond the commonplace anecdotal perception that the young take more readily to ISTs: there has not previously been the situation that a generation has grown up with ISTs surrounding them, but that situation is now arising. In the case of value change, it is understood that (e.g.) economic values are crucially influenced by economic conditions in an individuals formative years. IST values and the consequent lifestyle influences must surely be crucially influenced by the IST climate and by the consequent lifestyle influences in an individual's formative years. The third major factor identified as central to lifestyle change is thus generational succession .As a result, immaterialisation's time scales are long term and its scope global; it is, however, not revolutionary but relies only on ISTs that can already be seen in outline or in prototype form.

Immaterialisation would serve little purpose if it were subsequently to be un-wound or reversed by some inevitable mechanism or rebound.

Despite the apparent (and perhaps spurious) new-ness of the concept of immaterialisation, its rebound effect falls into a class of effects that are well known and which have been widely studied. The increase in electricity consumption observed to follow in the wake of price reductions was important in the early work on rebound effects, and identified the importance of the price mechanism, i.e. of price reductions. In considering Rebound-I, two factors are thus of particular interest. Firstly, does immaterialisation imply cost reduction; and then, to what purpose would the 'saving' likely be put by the consumer?

Immaterialisation challenges the neo-classical economic view of 'homo economicus', making rational consumption decisions, ceteris paribus, on the basis of cost and direct functional preferences alone. The choice to opt for immaterialisation is about lifestyle: such issues as upbringing of children; quality of life (as opposed to standard of living); and place in society weigh more heavily than cost issues. Immaterialisation may produce a cost saving: or it may not. It is *the pattern* of consumption that is changed, not necessarily or systematically its *cost*, nor (except very indirectly) its *function.*

A primary effect of dematerialisation is to reduce the price of the good in question. This increases the demand for that good, thereby wiping out some or all of the eco-efficiency gains. Rebound-D is thus essentially an own-price substitution effect.

In contrast, immaterialisation represents a major discontinuity. People can meet their desires in full at a (generally but not necessarily) lower cost, which in turn may leave them money to spend on other things, which may or may not be immaterial. Hence, rebound-I can be described as a predominantly income effect.

[197] Abramson and Inglehardt (1995).

## II.2 ISTs and Reducing Inequality

> Give me your tired, your poor,
> Your huddled masses yearning to breathe free,
> The wretched refuse of your teaming shore,
> Send these, the homeless, tempest-tossed, to me:
> I lift my lamp beside the golden door.
>
> Emma Lazarus, '*The New Colossus' (1883)* (Inscription on the Statue of Liberty, New York)

Introduction

1. There is a manifestation of poverty so extreme that it is associated with insufficiencies of food and water supplies; lack of medical care; very low life expectancy, and extreme misery and deprivation.

This condition applies to about one billion of the world's inhabitants, typically with annual incomes around 250$ or less, and is known in everyday language as absolute poverty.

2. Other manifestations of poverty are observed at much higher income levels and are associated with high levels of inequality in income distribution. Here the association is with lack of access to education (particularly for females) and with relatively low ages at completion of education; with lack of meaningful impact on political systems; with low expectations and low levels of ambition, and often with high levels of criminal activity, corruption and political repression.

This condition is known in everyday language as relative poverty: it has no single marker level of annual income but is a function of income distribution in particular states and regions: a typical expression of a level of relative poverty would be 'less than 50% of average income for the region'.

3. Should we so choose (and we not always shown a genuine will to do so), absolute poverty is a problem that could be ended at a cost well within the ability of the developed world to meet. Doing so would at the same time necessarily exacerbate the problem of relative poverty, so that the solution to one problem would bring others in its train, but there can be little doubt that absolute poverty is an issue in the domain of morals, rather than of practicalities, and the failure to address it is a moral issue, not one for the technologists.

4. Relative poverty, the issue of excess of inequality, however, is a quite different class of question. There seems to be little doubt that some degree of inequality in

societies is necessary to their efficient functioning: incentives to work seem to be more successful than punishments for not working (the carrot rather than the stick) for instance. However, there equally seems little doubt that, in some areas, absolute equality should be the aim (access to law, for instance). It seems at the least to be a possibility that there should exist some optimum pattern for the distribution of incomes in a society, and much debate has been undertaken around this theme. Indeed, the history of politics can in many respects be read as the history of debate on these quite technical issues of income distribution and equity. It seems then that, unlike absolute poverty, relative poverty offers fruitful ground in which the technologist may work.

5. Views of income distributions have, however, to be tempered by awareness of the existence of an absolute poverty line: a nation in which everybody has the same near-zero income might be seen as remarkably fair – but not as in any way a desirable model. Income distributions in the real world have characteristically different patterns under different social systems: other than in the singularities of revolutions, such patterns change relatively slightly over time. Change can, however, be induced – albeit slowly – and the long term modification of patterns of income distribution is a legitimate policy aim. The questions that arise are, what trajectories of change are desirable? And how are they to be achieved? These are complex questions: the apparent numerical certainties of money income measurement may, for instance, tell us little about the relativities of Quality of Life or of happiness. Similarly, different societal norms in regarding (for example) investment in healthcare for today as more valuable than investment in pensions for tomorrow, offer much scope for discussion without necessarily contributing to understanding.

6. TERRA's proposition is

*The new technologies of the Information Society (ISTs) offer scope to enable economic growth, and to allow a more equitable distribution of wealth, without necessarily increasing consumption, pollution and energy use.*

In order to expand on the understanding of this, we must therefore come to some understanding of the relativities of income distribution; and also of the creation of economic growth i.e. the absolute growth of incomes.

## II.3 ISTS and Increasing Human Ability and Potential

What a piece of work is man!
How noble in reason! How infinite in faculty!
In form, in moving, how express and admirable!
In action how like an angel!
In apprehension how like a God!

William Shakespeare, *Hamlet*, Act 2 Scene 2

It's people who do the damage – but its also people who do the good things. In both respects, numbers count – population figures matter absolutely, and age distributions affect us from cradle to grave – are there enough working people to pay for the education of the young – or the pensions of the old? And can a lack of a sufficient working population be addressed by immigration – or does that just move the problem one block down the road – or one country across the globe? Population figures are relatively easy to predict in the short term – births and deaths, like aspects of life, follow 'rules', at least in the short run – but small changes in e.g. birth rates make vast differences to populations (and to age distribution) when considered over long periods of time. Policies have to be flexible to accommodate change, and the permutations of possibility are endless.

Human Capital, measured in money equivalent terms, is a very large proportion of all capital. A recent study by Alfred Herrhausen Geseltshaft, AHG, using estimates for the cost of education per person per year as shown in Figure 1, estimated the human capital in Germany at €12.4 trillion in the year 2000; and suggested that this in future "will never be the same", declining to €8 trillion at the year 2050. For the sake of comparison in terms of the order of magnitude, taking the capital output ratio for Germany to be 2.5 with GDP at the year 2000 at €1.8 trillion, physical capital is only €4.5 trillion. The human capital for an average individual is assessed to be of the order of €one-quarter million.

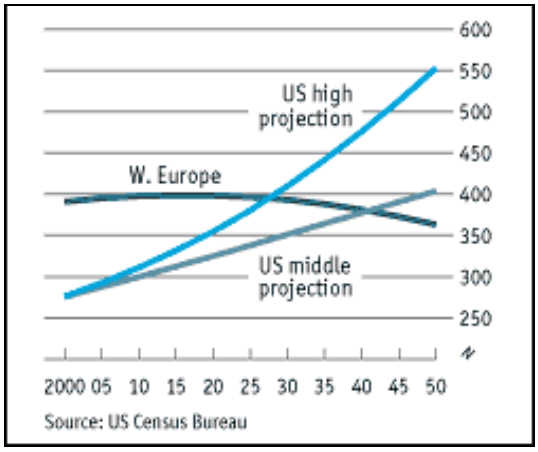
EU policy objectives to secure the human capital necessary for development and growth include:

- Take advantage of human capital foreign investment in the EU.
- Reduce unemployment.
- Advance the enhancement of social capital as the *"glue that holds society together."*[198].

[198] Stiglitz (2002).

A model has been developed to facilitate examination of the underlying mechanisms. It has economic, demographic, technological and world trade sub models.

Figure 19 shows the anticipated population for the USA and the EU, while Figure 20 shows the labour force (in millions) for three regions.



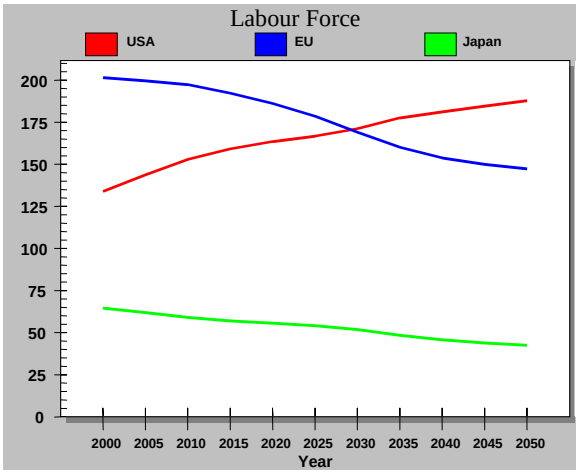




Figure 19: Projected population, million

Figure 20: Projected labour force, million

Some basic assumptions and parameters for analysis include:

- ICT consumption growth rate
- GNP growth rate
- Free flow of ICT human capital
- Population growth
- Labour force
- Tertiary education
- Foreign human capital in terms of the number of ICT high-level professionals relocating to the European Union.
- Labour productivity increase based on knowledge acquisition
- Investment in tertiary education

Outsourcing

Human capital import in terms of professionals represents, in affect, foreign investment, in this case in education rather than in financial or physical capital.

To take this into account, the policy objectives should not be pursued in terms of optimising, e.g., minimizing human capital imports but rather in terms of the bounded rationality approach advocated by Herbert Simon in which tolerance levels are assigned to different objectives and the policy is selected which is “satisfactory”, i.e., leads to the acceptable level of policy success even if it is not optimal for a narrowed range of assumed externalities. .

Bars—Annual Immigration  Line—Cumulative Immigration

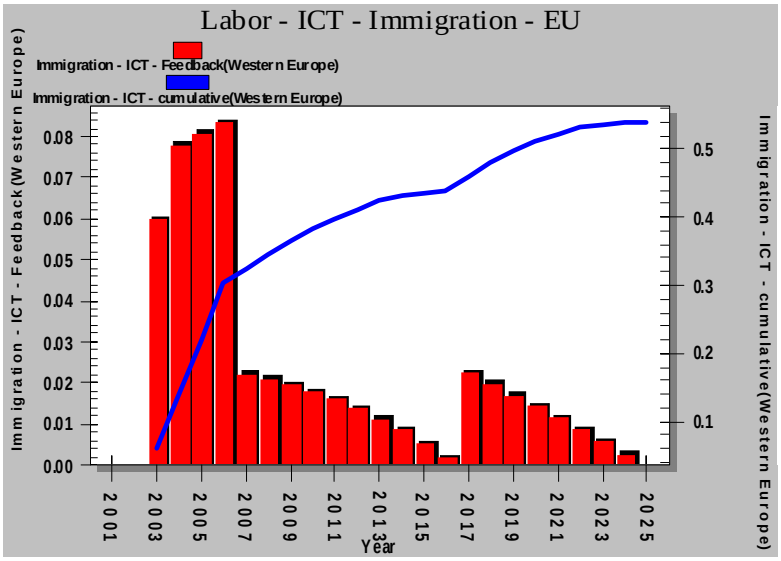



**Figure 21: Immigration of high tech professionals**

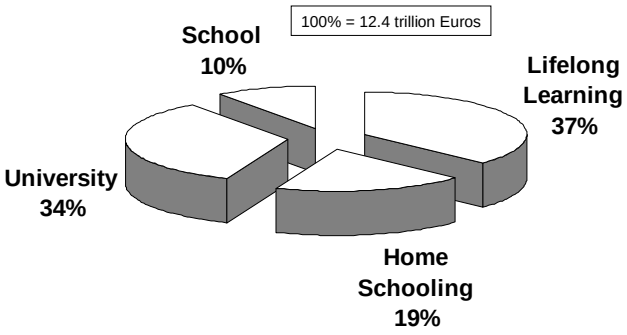



**Figure 22: Sources of human capital formation, 2000**

ANNEX

Focus of Analysis

To understand this issue better, four subsystems and their interactions should be understood, namely:

- Population,
- Economy,
- Labour and Immigration, and
- World Trade.

Globalisation and innovation in information are mutually reinforcing.

*"Germany's population is projected to fall from 82 million to some 60 million in the next half-century, with the work force shrinking from 41 million people to 26 million."* At the same time the US labour force is estimated to be close to 200 million. *For every worker in Germany there will be seven workers in the USA.*

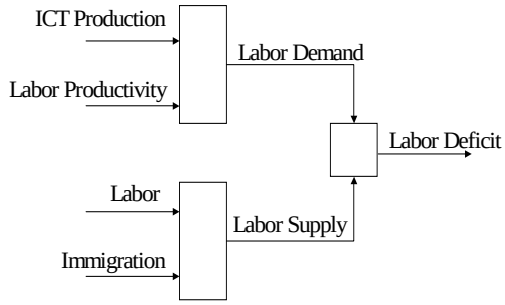



**Figure 23: Labour demand**

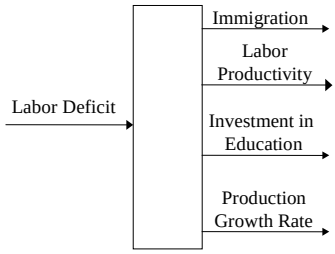



**Figure 24: Labour supply**

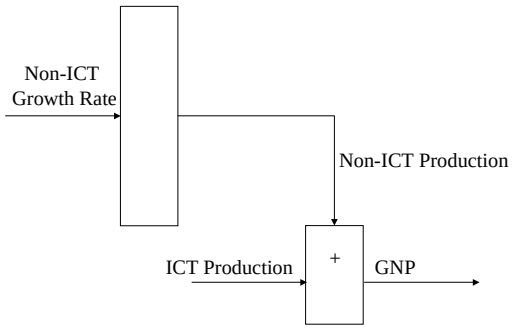



**Figure 25: Overall economy**

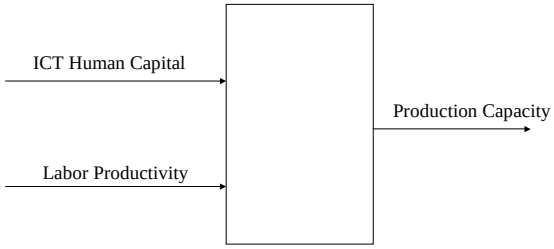



**Figure 26: Production capacity**

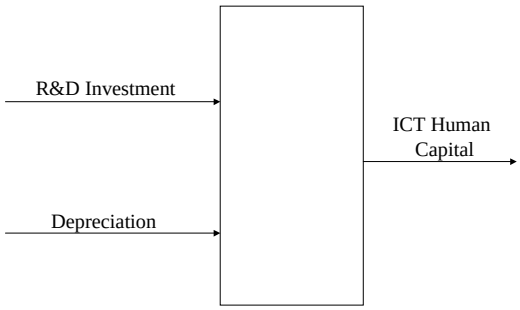



**Figure 27: Human capital formation**

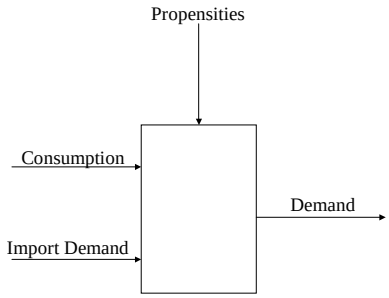



**Figure 28: ICT demand**

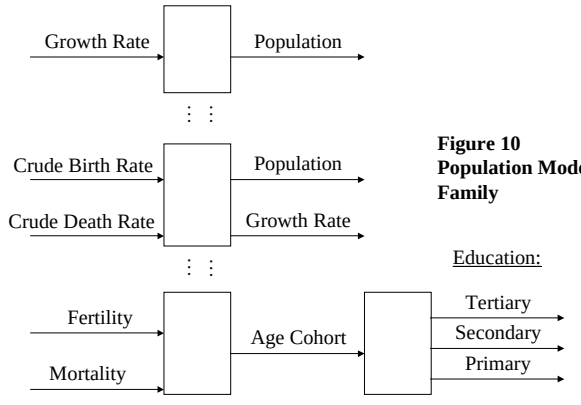



**Figure 10 Population Mode Family**

Education:

**Figure 29: Population change processes**

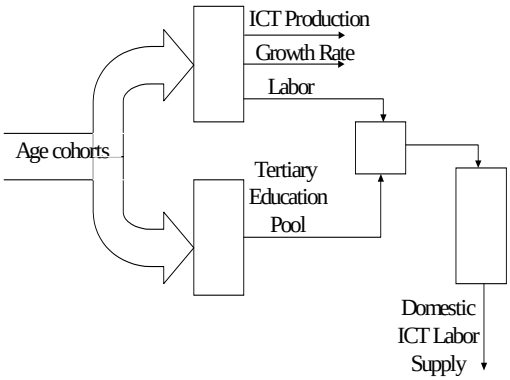



**Figure 30: Labour deficit rebound**

## II.4 ISTs and 'Weak Signals' of Coming Change

Madmen in Authority, who hear voices in the air,
Are distilling their frenzy from some
Academic scribbler of a few years back.

John Maynard Keynes, General Theory, 1947

Introduction

This section differs materially from its predecessors in that it concerns itself with the possibilities of discontinuities between the future and the present. The three preceding sections have based their argumentation on an understanding of the past and on long data series, which are essentially historical. It is very frequently (even, perhaps, generally) the case that yesterday and today provide us with the best guide that we have to tomorrow. However, change is also eternal: there are always 'shocks' against which our systems need to be resilient, and there are always large systematic changes which run as it were orthogonally to our present understanding (the ICT industry itself would have been such a change as seen in the middle decades of the last century) whose early manifestations may seem currently to be either trivial or irrelevant, but yet which may be enormously significant in the future. Equally, of course, such 'orthogonal' change may prove to be of no consequence. As is frequently said of advertising, 90% is of no consequence and only 10% is useful – but we don't know which 10%. Weak Signals have something of that quality.

It is necessary, therefore, to keep 'half an eye' on such developments: this is the purpose of monitoring 'weak signals'. Weak Signals question both the extent of our understanding (do we know enough?); and also the validity of our understanding (is what we know of any relevance?). The monitoring of Weak Signals is thus intended to overcome the risk that we only ever draw conclusions that can be expressed within the language of our existing understanding and (historic) knowledge.

Among the topics where we may possibly detect 'Weak Signals' of coming change are:

- **Welfare Saturation** There are some reasons to think that human behaviour exhibits systematic changes once such a level of wealth (or rather welfare) is reached that the desire for further material consumption becomes blunted.

- **The Fifth Wave** In the view of change as being characterised by long cycles of economic activity spurred by waves of technical innovation (Kondratieff's Waves) the Information Society is generally seen as the current wave – but if that is so, then we should already be able to see the first signs of the next wave. Bio-technology, nano-technology and a wide view of McLuhan's 'Extensions of man' are frequently cited as components of the Fifth Wave.

- **The Subjectivity of Money** Economic bubbles, whether based on tulips; on railways, or on dot.coms, naturally lead in their aftermath to questions about the subjectivity of money. Ostensibly the post-Bretton-Woods, post-gold standard, world accepts subjectivity at one level (for instance hedonic indexing) whilst affecting to maintain objectivity at other levels (for instance pensions and the fight against inflation). This delicate societal balance may yet prove to be unstable in a deflationary environment: governments may strive for the creation of money wealth, yet still fail to satisfy those whose understanding of money is different from the norm.

### II.4.1 WSF #1: Welfare saturation

Description

There is an implicit link between GDP/capita; welfare; and consumption. These are rather loosely assumed to follow trajectories that are at least sub-parallel.

However, many commentators assert that welfare has become de-coupled from GDP increases and is static or declining in many developed economies[199]. That assertion can, however, be read as no more than a re-definition of welfare in non-monetary forms. Nonetheless, new data shows that some basic consumptions (e.g. energy) ) may cease to rise with GDP/capita after a certain point[200]. Taken together, these two related possibilities might be taken to mean that there exists a level of GDP/capita (not necessarily fixed over time) that represents 'Welfare Saturation', beyond which neither welfare nor certain elements of consumption increase with increasing income.

Potential Implications

The existence of a concept of welfare saturation would introduce a number of consequent changes in perception in different domains:

Economic

At the point of saturation, the rational buying behaviour of homo *economicus* would apparently change – but to what? Behaviour seems to derive from values and beliefs – so what changes here? The aspiration element in motivation must somehow be affected – but how? And what new buying patterns replace the old? Does this accentuate (or even in part account for) the shift from goods to services?

Sociological

Money may never have bought happiness, but nonetheless the fallacy seemed to work for many people. If happiness levels peak and then either remain static or fall, does life become a certain route to disappointment? Is the prospect of some sort of 'betterment' a necessary part of the condition of man (as in 'life, liberty, and the pursuit of happiness') or is stasis a comfortable state (as in 'liberté, fraternité, égalité')?

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[199] E.g. Daley and Cobb (1994), especially the chart on p 464 and its surrounding text and tables.

[200] Shell (2001), see especially diagram on p31.

Environmental

If there is an upper bound to the consumption of energy per capita, then there is an implied upper bound to e.g. the creation of pollution. This is superficially a good thing; but then will that upper bound become, in its turn, the accepted norm when developed nations negotiate on emissions? And what (presumably immaterial, or at least less material) consumptions will occur post-saturation? The Rebound from immaterialisation is an income effect, so a multiplier on the original situation of excess income. Does the excess income become meaningful investment? Or support more but different pollution?

Cultural

Anecdotally, interest in eastern, non-material, belief systems is on the increase in developed nations. Do cultural alternatives relate to welfare saturation and post-materialism? Hardt and Negri201 postulate an introverted, post-material dialectic as a necessary new foundation for political philosophy. Marxism has long seemed to be dead, but perhaps capitalism is following it: if Hardt and Negri are the best guides we have to the future, then politics as a whole is in trouble.

Tracking Indicators

Many indicators exist for welfare – possibly too many. ISEW seems directly relevant. Energy use is also widely tracked. The interest here, however, is at the margin – at the moment of welfare saturation, if it exists. Tailoring an indicator for the purpose would involve hypothecating post-saturation activities (e.g. an increased interest in spirituality) and tracking it (e.g. the growth of the 'spiritual' sector).

Related Phenomena

There is a strong link here to the second entry in the WSF file – The Fifth Wave. If, as weak signals may indicate, the Fifth Wave were indeed concerned with 'The Extensions of Man' in the intellectual, sensual, and spiritual senses then this would tend to support the 'Welfare saturation' hypothesis. The third WSF entry, The New Subjectivity of Money, may also relate through the concept of hedonic Indexing if (as some more enthusiastic protagonists claim) the New Economy is actually the fallacious result of an erroneous belief in the existence of Welfare increases that have not already occurred. Much is open to dispute, but there is enough activity to demonstrate a 'Weak Signal' here.

Observed Signals (in the press etc)

For a view on the overt search for happiness as welfare saturation approaches, see Diane Coyle's article (concluding 'the dismal science of economics is turning cheerful') the Independent (UK) 28.03.2001. See also the references, particularly the figures in the Shell Scenarios.

[201] Hardt and Negri (2000).

### II.4.2 WSF #2: The fifth wave

Description

The Information Society is not infrequently taken to be the 4th Wave of Kondratieff[202] (or sometimes the 5th, depending on the manner of counting)[203]. The waves originally postulated by Kondratieff seemed to have a period of about 60 years, but more recently it has appeared (e.g. to Schumpeter and others) that the wave length may be decreasing so that the 4th Wave may only have a life of perhaps 40 years or perhaps even less. At the extremes of the range of foreshortened predicted figures, the 4th Wave could trough at about 2020 - and could already have peaked. If that is the case, and if we are already in the decline phase of the Information Society Wave, what might be the clues available to us about the nature of the forthcoming 5th Wave?

A Kondratieff Wave is no small phenomenon: the protagonists of Long Wave Theory see its influence in every aspect of life[204]. Such a vast wave should already be visible, if only as a speck on the horizon. The 'core' of a wave has, in the past, lain in socio-technical development triggered by the coming to maturity of some aspect of scientific advance; it has directly affected the day-to-day life of the vast majority of individuals in developed nations; and it has dominated the economics of its day. Perhaps most significantly, one can (with full hindsight) see in each previous case the evidence that the wave was inevitably coming, everywhere in view but unrecognised as to its significance, even though each wave tends to prefigure the next long before the arrival of the wave concerned. What then do we see today that meets these criteria? What is it about today that prefigures tomorrow yet goes unrecognised?

McLuhan[205] was fond of describing media technologies as being 'Extensions of Man'; television was an extension of our ability to see, for instance. McLuhan's 1951 vision of the then-coming 4th wave (made at or before the peak of the 4th wave) also offers clues about the 5th. Quite possibly the largest single business worldwide at the peak of the 4th wave was illicit pharmaceuticals (or 'recreational drugs'): a huge anomaly in the Information Society, but one which is effectively devoted to McLuhan's prosthetics: extensions to mans ability to imagine; to enjoy; to perform athletically etc. Perhaps even more surprisingly, elective surgery (a natural but more radical companion to elective medication) has become commonplace. The old prosthetics (spectacles were possibly the first consumer item to go beyond the essentials of life) have been monstrously extended - breasts and lips are enhanced, and stomachs and thighs reduced, as a commonplace. (For a scenario that features elective physical modification extensively see Gibson's Idoru[206]). Cloning and the bio-chemical revolution are potentially imminent; and Kurzweil foresees synaptic mapping as a long step on the road to a Nietschian Ubermensche . At the same time 'spirituality' - the New Age', alternative religions, meditation etc, have come to new prominence, and counselling and personal development are all around us.

[202] Kondratieff (1926).
[203] See Freeman and Louca (2001) for a survey of Long Waves in general.
[204] As in TERRA-related document, Gaus (2002).
[205] This theme dates from McLuhan (1951).
[206] Gibson (1996).

There is at least some plausible evidence, therefore, that the 5th wave will be a further step on the road to the conquering of physicality - a further Extension of Man. (This would also chime neatly with the internalisation of the political dialectic foreseen by Hardt and Negri)[207].

Potential Implications

With previous Long Waves, Each new Wave has been additional and complementary to its predecessor, which declines only slowly. A half-period (perhaps 20 years) is likely to elapse before the full effects are realised.

Economic

Much of the existing activity in this sector is currently in the 'Black Economy', although 'laundering' allows some to appear as spurious increases in other sectors (the entertainment sector being apparently particularly favoured). It seems hardly possible that this situation can continue, but equally unlikely that a single over-night change will bring it totally into the visible economy. Filtering in over time will (perhaps) seem like growth, but no growth will be present. How will this affect the economy as a whole? Many factors already exist (see WSF #3) that allegedly give such spurious impressions of growth – is the Fifth wave merely a part of this new subjectivity of money?

Sociological

The 'Extensions of Man' in the Fifth Wave may possibly provide the new (replacement) focus for betterment as part of normative aspirations. If so, then perhaps Margaret Thatcher was right and there is (or at least will be) no such thing as society.

Environmental

Assuming that physical prosthetics are recyclable (as is the case with gold teeth) then 'Extensions of Man' may prove to be a benefit from an environmental standpoint. Previous Waves have often been marked by a physical monumentalism whose decline into less material values might result in reducing the 'A' factor in the I=PAT equivalence.

Cultural

The Fifth wave postulated would present most visibly in the Cultural sector: counter-Culture would prevail, but counter-Culture is very heterogeneous, fractured, sqabblesome thing. Seen as an overlay to existing cultures it would be anarchic but not necessarily destructive: the pre-existing cultures might survive almost unmodified.

[207] Op Cit in Weak Signals #1 – Welfare Saturation

Tracking Indicators

Despite its 'black' status, some good data sets exist to track illicit pharmaceuticals – seizures in particular. Elective (cosmetic) surgery is a trackable sector, as is that of social 'Counselling'

Related Phenomena

The 'spiritual' sector concept aligns with WSF1 (Welfare Saturation).

Observed Signals

Despite past avowals that narcotics trafficking in China had been eradicated, China now concedes that it's been waging a losing battle against illicit drug use. Seizures of heroin and marijuana increased 34% and 137%, respectively, in 1998, and the number of addicts is estimated to have increased almost ten fold in the past decade. Rising unemployment and poverty due to the slowing economy and public sector reforms are considered partly to blame.

Ironically, in a country in which drug traffickers oftentimes face immediate execution after public trials, some restaurants are giving a nod to the drug culture by offering dishes seasoned with a few grains of opium208.

Many more forward views are to be found on www.csf.colorado.edu/longwaves

### II.4.3 WSF # 3: The new subjectivity of money

Description

Concepts of subjectivity are not easy to apply rigorously to money. However, during the time of the Bretton Woods Agreement, there was at least a wide general belief (true or not) that money could be regarded objectively.. From 1973 onwards, that view has been more and more replaced by a more subjective attitude. As a simplification for the purpose of argument, money has changed from being almost entirely objectively defined to being almost entirely subjectively defined, at least in public perception.[209] There are analogies here with statics and dynamics; with the 1st and 2nd Laws of Thermodynamics; and perhaps most of all with the fundamental nature of Process as defined by Whitehead[210].

From such a viewpoint, the break from the Gold Standard in 1973 would represent the moment of change from the old paradigm (of spurious appearance of precise equivalence to a physical entity), to the new paradigm (of the mere description of activity). One might then anticipate some discontinuity in data using money as a measure, from around 1973 (allowing for some lag in the development of the new perception).

[208] Source: 'Bewildered China Faces a Surge of Drugs,' Agence France-Presse, 1 July 1999.

[209] See the Mansion House Speech by David Boyle, reported in the 'Independent' of 26 June 2002.

[210] Whitehead (1938).

## Potential Implications

Two different major factors would contribute to discontinuity in figures relating to the economy – the undermining of the statistical base and the knock-on effect of changed public perception on economic performance.

### Economic

Purely because of the change in the statistical base, a progressive deviation between non-money based economic indicators (exergy use, for example) and money-based indicators (GDP, for example). (From this particular standpoint there is no particular reason to predict the direction of the deviation, only that one should exist). This, however is a technical issue: many efforts are made to eliminate such distortions (often accompanied by some controversy) – MFP is one such mechanism, hedonic price adjustment another. Both have specific significance for TERRA and for the IST sector.

### Sociological

This is primarily an economic issue, but a (? Non-trivial) effect to be expected would be a growing divergence between public (i.e. anecdotal) views of the economy, and technical views of the same economy. There is some limited 'soft' evidence of this[211]

### Environmental

A further (? Non-trivial) effect to be expected would be a growing disparity between 'achieved' environmental impacts and those predicted by extrapolating economic growth.

[211] Article in the Times April 26 2002 by its Financial Editor, Graham Searteant

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# IV TERRA Deliverables

The following Table lists and briefly describes the main project deliverables.

| Number | Title | Description (where not obvious from title) |
|---|---|---|
| D 1.1 | Report on TERRA2000 vision, structure and key concepts | |
| D 1.2 | Project presentation document | |
| D 1.3 | Report on model requirements, framework and protocol | Ground rules for the modelling efforts |
| D 1.4 | Initial dissemination and use plan | |
| D 2.1 | Initial working paper on NEMO representation | Papers relating to the first-generation Network Effects Model covering spread of knowledge and the knowledge economy (the networking theme was ultimately taken up in NAUTILLUS) |
| D 2.2 | Preliminary NEMO requirements definition | |
| D 2.3 | NEMO data dictionary | |
| D 3.1 | Initial working paper on social fabric representation | Papers relating to the first-generation models of social dimension of the GNKS (which fed ultimately into the Social Accounting Matrix in IFS for TERRA) |
| D 3.2 | Preliminary SOFI model definition | |
| D3.3 | Measuring Social Fabric: Indicators and data dictionary | |
| D 4.1 | Report on modification of US macro module | Papers relating to the macroeconomic growth and energy use models (which form the basis for the REXS modelling system) |
| D 4.2 | Preliminary MARGRET requirements definition | |
| D 4.3 | MARGRET data dictionary | |
| D 4.4 | Report on additional major country macro modules | |
| D 5.1 | Initial working paper on sensitivity analysis and collective, modular model development | Papers relating to the collective modelling framework (used to develop the paradigmatic VenSim models) and structures behind the policy cockpit in IFS for TERRA |
| D 5.2 | Initial working paper on collective modelling technology | |
| D 6.1 | Initial report on data needs, sources, and responsible teams | Papers relating to the modelling of IFs for TERRA and to project-wide data collection and documentation |
| D 6.2 | Report on data-handling and data-analysis capabilities | |
| D 6.3 | Databases for WP 2-4 | |
| D 6.4 | Help system documentation | |
| D 7.1 | Model prototypes | |
| D 8.1 | Report on policy oriented input scenarios | Papers relating to project-wide scenario development framework. 8.2 Includes a large number of scenarios and framework dimensions. |
| D 8.2 | Working paper on Scenario Formulation and Analysis | |
| D 9.1 | Identification of discourse partners | Papers relating to societal discourse activities during first phase of project |
| D 9.2 | Conference report | |
| D 10.1 | Website and short report on website creation and activities | |
| D 11.1 | TERRA 2000 Annual Report, Year 1 | |
| D 11.2 | TERRA 2000 Annual Report, Year 2 | |
| D 11.3 | TERRA 2000 Final Report | |
| D 12.1, 13.1 | Human and Social capitals in the Information Age | Combined thematic analysis for Human Capital (WP 12) and Equity and Growth (WP 13), including dominant relations modelling of ICT economy and equity/growth dynamics, a range of scenarios and policy prescriptions relating to these themes. |
| D 13.1 | Equality and Diversity in the Information Age | Description/abstract needed |

| Number | Title | Description (where not obvious from title) |
|---|---|---|
| D 14.1 | Thematic analysis report on Sustainability in the Information Age | A *comptes rendus* on the work of the consortium as it relates to the sustainability analysis of the GNKS in the economic, social and environmental domains. This includes: specific descriptions of the indicator based Advanced Sustainability Analysis and IFs for TERRA (as related to the environmental theme) modelling systems; exploratory, Finnish and global framework scenarios; a range of case studies; and policy perspectives and recommendations |
| D 15.1 | The Story of Terra (short) | This is the 'short story' of TERRA, produced in various fora as a brochure and finally as a document for wide dissemination. It describes the propositions, the project's approach and the main results. |
| D 15.2 | The Story of Terra (long) | This provides a more complete account of the substantive work of the project, covering: the propositions; the project backbone and conceptual framing; the data, analysis and scenario tools; specific policy perspectives relating to human and social development and to environmental and ecological considerations; and a road map of future work. |
| D 15.3 | Modelling platform | Final version of the IFs for TERRA software, including all databases, policy cockpit and online tutorial, documentation and help files. |
| D 15.4 | Scenarios living document | Presents a unified summary of the scenario frameworks and scenarios developed in the thematic and crosscutting work. |
| D 15.5 | Tools and Models Final Report | Outlines tool development over the project. Discusses conceptual foundations, development paths, and the status of tools created within TERRA. |
| D 16.1 | Brochure | |

# V TERRA Publications

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