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March 2006

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Scenarios for future scientific and technological developments in developing countries 2005-2015

March 2006

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Summary

This document is the final report of the European Commission (EC) funded project *Scenarios of future science and technology developments in developing countries* hereafter referred to as SCOPE 2015. The report describes the rationales for the project, its scope and coverage, and the process that was followed. It also presents the project's results, which are focused upon four regions: the Commonwealth of Independent States (CIS); Sub-Saharan Africa (SSA); Maghreb and Mashreq (MEDA); and Latin America (LA). Some generic conclusions and recommendations are highlighted in a final section. Here, the project and its findings are briefly summarised.

The EC and RTDI cooperation with third countries

For more than 20 years, the European Union (EU) has been supporting research cooperation with countries in all parts of the world, the objective being to promote sustainable development and research, technological development and innovation (RTDI) partnerships. This cooperation has been implemented through comprehensive International S&T Cooperation programmes (INCO) within the frame of the EU's research activities. Between 1983 and 2003 more than 10,000 research teams, including more than 50,000 researchers equally represented by the EU and international cooperation partner countries, took part in more than 3,700 projects. Whilst these impressive numbers demonstrate the ability to mobilise relevant research capacity that targets common interest research, it is commonly acknowledged that more could be done in international cooperation, particularly given growing recognition of the role S&T cooperation can play in contributing to the wider international relations agenda. Accordingly, for the first time, the Sixth Framework Programme (FP6) saw the opening up of the whole of the EU's research portfolio to participation by third countries. But the level of participation in the main thematic lines of FP6 has been below expectations, leading to a reappraisal of how the EC should design and manage its international S&T cooperation activities.

The objectives and coverage of SCOPE 2015

The EC's INCO Unit already has processes in place in which it has been considering options for how international cooperation might be enhanced in the Seventh Framework Programme (FP7). SCOPE 2015 has been careful not to reproduce these processes but instead to establish a complementary process that looks farther out to FP8 and the year 2015 in order to consider a variety of visions (scenarios) of what international RTDI cooperation might look like. The process of thinking about these contrasting scenarios of the future should encourage policy-makers to examine the long-term implications of the decisions being taken today and, if necessary, to change policy directions to achieve more desirable outcomes. In other words, despite the ten-year time horizon of the project, it should have implications for policy decisions and actions taken today and in the near-future.

The specific focus of SCOPE 2015 has been upon RTDI cooperation with "developing countries", only a part of the EU's international RTDI cooperation

coverage. Four regions have been covered, namely the Commonwealth of Independent States (CIS), Sub-Saharan Africa (SSA), Maghreb and Mashreq (MEDA), and Latin America (LA). Not all countries in these four regions would normally be described as "developing countries", but the label has been used in this project to distinguish it from a sister project that has focused upon the "emerging" BRICS economies (Brazil, Russia, India, China, and South Africa). All four regions are important strategic partners for the EU for a variety of different reasons, such as trade, investment, protection of habitats and the global environment, international security, migration, and so on. In turn, RTDI can make important contributions to all of these policy areas.

Two of the regions being covered are EU neighbours, i.e. CIS and MEDA. As a matter of priority, partnerships and cooperation are being developed with the countries in these regions with which the EU already shares many common objectives. The development of such partnerships is intended to contribute to the establishment of a competitive, coherent and open European Research Area (ERA), which should, in turn, add to the economic, political and social consolidation of Europe.

For the other two regions, i.e. LA and SSA, Europe has extensive historical and cultural links that naturally extend to RTDI cooperation. RTDI progress in many countries in these regions is fundamental for their economic and social future, for global welfare and for worldwide equilibrium. Expanding scientific and technological cooperation with these countries may also be a vehicle to achieve other important goals, such as improved relations and support for the EU position on an array of global issues. RTDI relations with them should be founded on a commitment to equitable and sustainable development.

The limitations of SCOPE 2015

The fact that there is no single body analogous to the EU in these four regions means the project has had to focus on the national level for its RTDI data. Due to the relatively short duration of the project (around 11 months) and its modest budget (approx. €100,000), just four countries in each region could be covered in detail. Whilst attempts were made to achieve a representative cross-section of countries, it has sometimes been difficult to do justice to the full variety in the regions. Moreover, aggregating national trends and issues to the regional level can be problematic, since they are rarely important for all countries in the region. The project team has tried to deal with this by focusing mostly upon headline trends and issues that are apparent in the majority of countries. But this is not without its consequences, with important national specificities necessarily sacrificed through the process of aggregation. Also, the deliberate omission from the study of large countries like Brazil, Russia, and South Africa (covered in the sister "emerging" economies project) has perhaps resulted in incomplete and possibly distorted views of the regions, although it has had the advantage of concentrating attention on those countries that are often neglected in such regional studies.

Given the broad scope of the project and its limited resources, it has not been possible to identify specific RTDI areas where the EU should focus its cooperation efforts (other than in a general way). To do this, more extensive national

analysis in more countries across each region would have been necessary, requiring more time and resources. Instead, the project has concentrated largely upon those dynamics associated with the *framework conditions* for RTDI activities in the regions. This means the main focus has been on trends and drivers that are internal and external to the national RTDI systems in the regions and the implications these might have for RTDI cooperation with the EU. Internal trends include things like national RTDI spending patterns, the use of science by national socio-economic actors, such as governments and industry, institutional and policy reform programmes, and so on. External trends include things like the internationalisation of skilled labour markets, aid donor strategies, and the activities of transnational corporations. The uncertainty, yet importance, of these sorts of trends and drivers make a scenario approach particularly suitable when thinking about the framework conditions for future RTDI cooperation.

The SCOPE 2015 process

To understand and build for the future requires an appreciation of developments and dynamics in the past and the present. Moreover, an important principle of EU RTDI cooperation is that it should be founded on active and constant dialogue with partner countries and regions, and sensitive to the socio-cultural approach of each partner country. This was the starting point for the SCOPE 2015 process, which began with the appointment of appropriate science policy experts as National Correspondents in the fifteen selected countries, each of whom was tasked with providing a Country Report. These provided a dynamic picture of past and current developments in national RTDI systems and were validated by other national experts in each country through a web-based discussion forum. After validation, the Country Reports were synthesized and collated into four Regional Synthesis Reports, which sought to draw out the main trends and drivers at work in each of the four regions and to speculate on their possible future trajectories. The latter were articulated as sets of ten-year forecasts, which were discussed and debated among National Correspondents through teleconference consultations.

In the wake of these consultations, three baseline scenarios were generated for each region. The aim was to expand the "possibility space" for RTDI-related developments over the coming decade by articulating distinct and contrasting future visions and "future histories" in each of the scenarios. None of the scenarios were intended to be predictions of the future. Instead, they were suggestive of the ways in which future developments might unfold and attempted to highlight the links between current and near-future policies and longer-term consequences. The scenarios were the main input into a Scenario Workshop organized in Brussels in June 2005, where all National Correspondents were brought together with EC officials and others with an interest in RTDI cooperation for development issues. The aims of the Scenario Workshop were to generate a "Success Scenario" for RTDI cooperation between the EU and each of the four regions and to identify a set of concrete action points. The results of this Scenario Workshop were later presented and discussed at a Policy Forum in Brussels in November 2005, and a number of practical actions suggested. Below, some of the main findings for each region are highlighted.

Commonwealth of Independent States: cooperation among Europeans

Four countries in the region, Ukraine, Kazakhstan, Azerbaijan and Georgia have been covered by the project. It is apparent that national scientific systems, formed for the most part back in Soviet times, have been degraded since the fall of communism and struggle to be relevant in the new environment. Insufficient resource allocated to RTDI has resulted in obsolete equipment, a gradual reduction in the number of researchers, and the collapse of many branch (industrial) research institutes. Less than half the S&T jobs that existed in 1990 remain in 2005, whilst much of the best talent has left the region to find employment in the West. Reversing this brain drain will require not only an increase in spending, but also extensive reform of the RTDI system. Necessary reforms include institutional consolidation, expansion of competitive streams of funding, restructuring of career pathways that reward on the basis of merit, and greater prioritisation within RTDI spending.

Support from the EU and US, through both direct project funding and researcher exchanges, have allowed some scientists in the region to maintain a high scientific standing. Early rationales for this support were focused upon eliminating the threat from weapons proliferation. For the most part, this threat has now been neutralised, so continuing international support is dependent upon the articulation of new rationales, perhaps focused upon wider notions of economic security. Whether the EU and US will vigorously implement cooperation policies to support the development of knowledge economies in the region is open to question. At the same time, close neighbours, China and India, are likely to play an increasingly significant role in supporting RTDI in the region.

Against this background, the main cooperation policy challenges associated with the region include (1) changing mindsets and perspectives on the utility of research and innovation to sustainable socio-economic development; (2) developing the "knowledge diplomacy" necessary for mainstreaming research and innovation agendas in the EC's Neighbourhood Policy; (3) implementing national institutional reform and consolidating research efforts; (4) promoting innovation through the extension of EU25 policies and programmes to the CIS region; (5) encouraging investment and partnership by the EU25 private sector; (6) raising awareness of EU opportunities and improving participation rates by the region's scientists; (7) building more extensive intra-regional collaborative links; and (8) achieving greater coordination with the RTDI cooperation activities of other countries and international organisations active in the region.

Sub-Saharan Africa: putting innovation at the heart of development

The project has covered four countries in the region, namely Botswana, Ghana, Kenya and Nigeria. In general, scientific effort is strongly concentrated in medicine and biomedical research plus biology (covering agriculture), with research spending well below 1% of GDP. All countries have a mix of university and institute based research with a very limited role for the private sector. Whilst there is a lack of real political commitment and interest in science and innovation, international (IMF austerity) and national programmes negatively

impact on the resources available for RTDI and result in lack of priority for S&T driven development. Trade restrictions and agricultural subsidies in the West distort markets and in turn give the wrong signals for scientific priorities. Poverty reduction and sustainable development remain key formal priorities dominating the national agenda but without a sound scientific base (grounded in significant investments in RTDI), policy measures remain superficial and lack effectiveness.

All of the countries depend on support from multiple donors, operating both bilaterally and multilaterally. National funding tends to be committed to salaries and basic institutional costs. Donors provide funding, some logistical inputs and some sponsorship of training. This gives them a strong influence over the content and direction of research. In the short run these inputs are beneficial, even essential, but there are concerns about long-run dependency and reactive rather than proactive policymaking. Further concerns raised are that funding of this kind prevents countries in the region from developing their own "joined-up" strategy for science, technology and innovation because each project is an opportunistic response to different donor strategies. Efforts are thus often fragmented and not sustained beyond the lifetime of projects. Benefits of international cooperation are insufficiently exploited on many levels, including lack of opportunity for policy learning, and lack of development of institutional and technical capacities.

Against this background, the main cooperation policy challenges associated with the region include (1) introducing an Africazone RTDI Scoreboard or Trendchart; (2) introducing an RTDI Cohesion Plan (modelled on experiences in EU) to address regional disparities and assist weaker regions; (3) establishing triangular research partnerships with the EU and other regions of the world; (4) using FDI and multinationals to build the regional innovation system; (5) providing support for start-ups, young entrepreneurs and entrepreneurial universities but within a coherent national/regional innovation strategy that is relevant to social and economic needs; (6) setting-up a network of Framework Programme National Contact Points for Africa; (7) raising awareness on the importance of science and engineering investments to address basic needs and as vital in all policy areas; and (8) supporting skills development in science policy management and policy design in government.

MEDA countries: creating prosperity together

Three MEDA countries have been covered by the project, i.e. Jordan, Morocco, and Tunisia. Regional expenditure on research is very low, whilst investment in research by private companies in the region is almost non-existent. Some MEDA governments have started to address issues related to innovation and the role of science, technology and engineering in economic growth. European investment in the region has become increasingly technology intensive.

Whilst budget has been set aside to finance the participation of MEDA scientists in projects under the EC Framework Programme, in reality it has proved very difficult for MEDA institutions to cooperate on this basis. They lack critical mass in terms of their research activities, they lack opportunities to develop the relationships essential for building research collaboration and they lack the image of excellence that is essential for participation in consortia that must compete

fiercely for the funding of projects they propose. Although the MEDA Association Agreements refer to cooperation in research, very little has been done so far to support Euro-Mediterranean cooperation in RTDI on the basis of MEDA Programme funds.

Against this background, the main cooperation policy challenges associated with the region include (1) funding INCO Preparatory Actions to leverage sources of Structural Funding; (2) supporting triangulation initiatives with the whole of the African continent; (3) meeting the grand challenges facing society; (4) cooperating on mobility; and (5) engaging with emerging technologies.

Latin America: towards a Latin American Research Area

The project has covered four countries in the region – Argentina, Chile, Colombia, and Venezuela. The overall political and economic picture of the Latin American region has been turbulent, fragile and continuously showing radical changes that directly affect national budgets for RTD. Over the last 10 years, regional spending on research has oscillated between 0.2% and 0.7% of GDP. National scientific systems in Latin America began to show some shape only after the 1970s, with much institution building supported by the likes of UNESCO. As well as research universities, a considerable number of Latin-America's key leading industries are State-owned (Oil, mining, etc.) and within this specific context there are state-of-the-art world leading technology development processes.

Latin American countries have little dependence on support from donors. The broader spectrum of scientific diplomacy has become more multifaceted as new actors such as China, Korea, India, and more recently, Arab and African countries engage in bilateral alliances with Latin American countries, usually with a product development focus.

Against this background, the main cooperation policy challenges associated with the region include (1) changing European mindsets and perspectives on the potential of the Latin American region; (2) promoting a 'Latin Agenda' by means of a coherent and supportive "knowledge diplomacy" necessary for mainstreaming social development, research and innovation at the regional level; (3) encouraging and supporting institutional reform and consolidating research capabilities; (4) making more reachable EU opportunities and increasing participation rates by the region's scientists; (5) supporting emerging sub-regional integration initiatives; (6) promoting mutually beneficial RTDI cooperation with each country and the international organisations active in the region; (7) promoting mutually beneficial cooperation between the EU and Latin America; and (8) achieving greater coordination of existing horizontal EC programmes in Latin America.

Building from SCOPE 2015: where next?

Despite their future-orientation, scenario exercises highlight issues that need to be addressed today or in the near future. SCOPE 2015 has been no exception in this regard, identifying ten generic recommendations deserving further attention by the EC:

1. Transferring the ERA concept to other regions through the establishment of regional research areas in places such as Latin America and Sub-Saharan Africa.
2. Furthering coordination on cooperation policies and programmes among the DGs of the EC, and between the EC and the national agencies of the Member States.
3. Ensuring a balanced portfolio of measures and programmes that support a range of cooperation activities.
4. Mainstreaming "knowledge policies", i.e. introducing RTDI policies into all areas of the EC's international cooperation activities.
5. Promoting re-organisation of national research systems around interdisciplinary problem-focused centres of excellence through incentives and policy transfer.
6. Supporting entrepreneurship and start-ups within the framework of a coherent national/regional innovation strategy that is relevant to socio-economic needs.
7. Actively managing mobility of researchers and students to build local capacities and avoid the occurrence of damaging brain drains.
8. Enhancing information flows about RTDI cooperation opportunities to researchers in both third countries and EU Member States.
9. Raising awareness of the crucial role of RTDI policy for development and building local capacities to develop and deliver sound and effective policies
10. Conducting further foresight-type exercises to examine the opportunities and threats associated with a myriad of issues concerning RTDI developments.

These action areas are meant to be additional to the reform agendas that need to be adopted by national governments in the four regions. In fact, many are complementary or even catalytic to such reform agendas. This is broadly in line with the principle of equitable partnership that should underpin RTDI collaboration between third countries and the European Union. Clearly, such partnerships need not be restricted only to science project cooperation but should also be extended to support the necessary framework conditions for RTDI cooperation to flourish more generally in the future. Indeed, without paying sufficient attention to these conditions, there is a real danger that little RTDI capacity will remain in some parts of the four regions covered, reducing the scope for future cooperation with Europe. The ambitious objectives of this modest project have been to highlight these dangers and to offer alternative visions of more desirable futures. Only time will tell whether warnings have been heeded and opportunities seized.

1. Introduction

This document is the final report of the project *Scenarios of future science and technology developments in developing countries* hereafter referred to as SCOPE 2015. It has been prepared by a team from the University of Manchester (Policy Research in Engineering, Science and Technology – PREST) in cooperation with partners from CKA of Belgium, the Malta Council for Science and Technology and Steinbeis-Europa Zentrum, Germany. The main objectives of this work were:

- To produce scenarios for the year 2015 focused on contextualised scientific and technological developments in selected regions of developing countries;
- To analyse the consequences of the scenarios for Europe and European RTDI policy; and
- To use the above to provide advice to the European Union (EU) in the field of RTDI policies in relation to developing countries.

This report summarises the context, the approach adopted and key findings on cooperation policy targeted on selected countries in four regions: The Commonwealth of Independent States (CIS); Sub-Saharan Africa (SSA); Maghreb and Mashreq (MEDA); and Latin America (LA).

The main achievements of the project can be summarised as follows:

- Identification and engagement of leading experts and policymakers in the targeted developing regions;
- Production of critical analyses of science policy and framework conditions with a prospective outlook together with the emerging conditions affecting international cooperation for each participating country;
- Validation of national reports using an online forum and peer review by participants;
- Setting up of a shared work space for sharing reports, relevant background documents and web-links across countries and regions;
- Teleconference consultations with the correspondents;
- Production of Regional Syntheses reports drawing out common threads in national reports and identifying key drivers for the 2015 foresight horizon;
- Engagement of EU and developing country experts in a foresight workshop to consider three input scenarios for each region and to develop a "Success Scenario";
- Validation and extension of results to policy application in a Policy Forum;
- Commitment of international cooperation policymakers evidenced by additional sponsorship of workshops and participation of senior

policymakers from three Directorates General of the Commission and three other international organisations;

- Plans for follow on activities including provision of specific advice on current cooperation strategy to DG Research and a Latin American Network continuing foresight activity.

Work on the project was carried out in the calendar year 2005.

The project generated a rich resource of background material, including National Reports for 15 countries, Regional Syntheses, and the Reports and Scenarios from the two Workshops held during the project. These are hyperlinked to this report rather than appended. The project has also developed a high specification website (http://les.man.ac.uk/prest/scope/) which has been used both as a research tool and as an instrument for dissemination of the findings.

2. Context for international cooperation

The political and economic future of Europe depends not only upon internal drivers of socio-economic development and governance but also upon its relations with the rest of the world. International trade provides a core foundation of European economies and, together with cooperation in areas such as health and protection of the environment, contributes to economic growth, welfare and quality of life. Recent terrorist attacks in Europe and ongoing threats have demonstrated the vulnerability of Europe and the permeability of its borders. The need for improved coordination of policy responses among Member States extends not only to areas of shorter-term action but also to the generation and dissemination of knowledge related to these issues, and the application of that knowledge through innovation.

Developing countries in particular represent areas both of substantial opportunity and of threat to European progress as well as raising a greater moral challenge and commitment. For those countries, the well-documented problems of poverty, health crises, international trade, lack of education, environmental degradation, poor governance, demographic shifts and, in some regions, war, are major barriers to progress. Globalisation and increasing connectivity means that developing country problems are not contained within their borders but reverberate to affect neighbouring regions such as Europe. This is particularly the case in view of growing migrant communities in Europe. Thus, in turn, European countries experience the consequences through migration, asylum-seeking and even as threats to security from terrorism.

Most developing countries / regions recognise that exclusion from the emerging knowledge society threatens to widen the gap still further. This places a central importance upon the role of science and technology and their relation to innovation. In turn, the role of international cooperation becomes a critical factor, both because of the high dependence upon the strategies of donors and through the linkages that it can provide to the European RTDI system and beyond to broader economic, social and cultural linkages. Scientific diplomacy forms one major motive for cooperation, along with other benefits to the EU such as access to unique ecological sites or resources, or populations. The extension of the European Research Area to these regions constitutes a mutual strategic advantage for both these developing regions and the enlarged Europe.

A full role for RTDI in development requires that other framework conditions are in place to ensure that it is properly supported and that it is connected to socio-economic priorities. Most of the countries covered by this study have already recognised the need for a national long term vision and in virtually every case science and technology have played a key role in these foresight-type activities. However, this project is unique in its scope, firstly in terms of its multi-regional focus and therefore its facility to compare findings and explore policy linkages across the four regions it covers; and secondly in terms of its particular emphasis upon international cooperation and eventual feedback to EU RTD and innovation policy.

Europe's emerging strength in the application of foresight to strategic policy design and formulation can be extended to these developing countries so that they can benefit on a number of levels: national, regional and trans-regional. Foresight approaches can also provide Europe with more appropriate tools for empowering these regions in a self-help/self-organising mode.

In the context of the Millenium Development Goals actions to combat poverty, infectious diseases, food insecurity, social and sustainable development all imply the application of knowledge. In turn development of the necessary knowledge base implies both a foundation in education and the extensive networking needed to achieve the necessary level of knowledge exchange and transfer. Even when there is a large disparity in the scientific resources available to Europe and its partners in the developing world, one-way transfer is not an option. Absorption and application of knowledge are dependent upon an active research capability in the developing country partner. Thus the challenge of capacity building becomes a central issue.

For more than 20 years, the EU has been supporting research cooperation with countries in all parts of the world. This cooperation has been implemented through comprehensive International S&T Cooperation programmes (INCO) within the frame of the EU's research activities. Between 1983 and 2003 more than 10,000 research teams, including more than 50,000 researchers equally represented by the EU and international cooperation partner countries, took part in more than 3,700 projects.

The decision to focus cooperation on the opening of all the sub-programmes, including the thematic priorities to third countries in FP6, constituted a major step forward in moving towards an open and equitable partnership with developing countries. However the experience in FP6 has demonstrated the constraints and under-exploitation of these opportunities due to hidden barriers limiting the participation of third country partners. While shorter term measures are needed to correct these aspects in the design of the Seventh Framework Programme, it is also timely to assess the longer term strategic direction of Europe's international scientific cooperation with developing regions. Taking a foresight-based approach means that the broader setting in which science operates and the dynamics of research and innovation systems become key issues. In the next section we describe how a methodology was designed to expose and extend these issues.

3. Methodology

Figure 1 gives an overview of the methodology of SCOPE2015. In the following sections key elements of this are explained in more detail.

Figure 1: Overview of Methodology

3.1 Selection of countries

With four regions to cover, it was impossible to choose all countries. Moreover, the project specification explicitly excluded Brazil, South Africa, and Russia, since these are being covered in another project of the Foresight Platform. Bearing these constraints in mind, the following criteria were applied when choosing the countries for consideration as a focus for analysis:

- Size;
- Trade relations;
- S&T capacity;
- Geopolitical importance;
- Existing RTDI cooperation with EU25 (bilateral and through the Framework Programme and other EU actions);
- Representative of region;
- Previous or ongoing national foresight activity.

The original specification had envisaged coverage of three countries per region. To improve representativeness, this was extended to four in three of the regions. It had been intended to include four in the fourth region, Maghreb and Mashreq, but it was not possible within the timescale and resources of the project to identify a national correspondent willing to report on Egypt. In Sub-Saharan Africa a partial report was also provided for Senegal but the correspondent withdrew before the work could be finalised. All choices were made in consultation with the Commission.

Table 1: Participating countries

Region	Countries	Comments
Commonwealth of Independent States	Ukraine, Kazakhstan, Azerbaijan, Georgia	Ukraine largest and geopolitically most important. Kazakhstan largest territory and substantial natural resources, reformed economy but human development problems. Azerbaijan as a fast growing economy by virtue of its significant oil reserves with some related science. Georgia represents a small republic with cultural links to Europe.
Sub-Saharan Africa	Nigeria, Ghana, Botswana, Kenya	Nigeria is Africa's most populous nation. Ghana is a strong scientific performer in the Anglophone region. Kenya represents relatively high research investment in East Africa and Botswana is economically important and stable Southern African nation.
Maghreb & Mashreq	Tunisia, Morocco, Jordan	Full geographical spread and balance between Francophone North Africa and East Mediterranean area. All are non-associated MEDA partner countries of high strategic importance and with substantial links to the EU.
Latin America	Argentina, Chile, Colombia, Venezuela	Argentina for size and strong historic links, Chile interesting case of reformed science policy system, Colombia high commitment to science and foresight. Venezuela is in a situation of transition but has strong historic links.

3.2 National reports

A template was prepared to guide the production of national reports and to aid subsequent synthesis. The key issues addressed are summarised in Box 1. A full version of the template is in Annex 2. It was recognised that with the limited resources available to correspondents and the lack of data in some cases, that not all of the points indicated in the template could be addressed in each case.

Box 1 Template for National Reports

1. Introduction
2. Historical policy and institutional developments
3. Contemporary institutional landscape
4. Role of donors and international organisations
5. National RTDI policy
6. Future visions/Foresight
7. RTDI funding: sources, levels and allocation mechanisms
8. Human and infrastructural resources
9. Ability to address emerging RTDI priority areas
10. International RTDI cooperation
11. Prospects for advancing RTDI in country references

Annexe 1: List of URLs for institutions highlighted in the report
Annexe 2: Statistical tables (optional)

3.3 Online validation forums

A first **online workshop** was used to validate and standardise the national analyses. National correspondents were asked to identify 10-15 people with expertise in the relevant issues. These were normally stakeholders and included permanent secretaries and other officials from ministries, vice-chancellors of universities, scientists from the public and private sector and other interested parties. Each nominee received an invitation from PREST to join a web-based debate on the validity and comprehensiveness of the relevant national report. Using specially designed software, invitees were able to log in and offer their comments over a period of several weeks. Valuable comments were gathered in ten out of fifteen cases. In one of the other cases the report arrived too late to launch a debate. In the remaining cases there was cultural resistance to public policy discussion of this kind. Debates were conducted in Spanish in the Latin American Region and in Russian in the CIS region.

3.4 Regional syntheses and second online workshop

The project team prepared draft Regional Synthesis Reports to generalise some of the key messages to emerge from the national reports, as well as to highlight any important differences. But more than this, they provided a more prospective outlook by setting out to elucidate some of the important trends and main issues at play in regional RTDI landscapes, and to discuss some of the "key drivers" that underpin current and future developments. The reports went further still by speculating on future directions of these key drivers (in the form of forecasts) and their possible impacts on the regional and national RTDI frameworks/systems.

The first part of the reports set out the main features of the national systems (including historical, institutional, policy, human and infrastructural resources, and donor relations features), highlighting both the similarities and differences

between national cases, whilst trying to account for these. The reports then turned to a description of the main trends and issues evident in the regional RTDI landscape. Finally, the reports described the "key drivers" that underpin the reported trends.

A second round of **online workshops** was held to validate and extend the **regional drivers** of RTDI-related issues. These were held as teleconferences involving all national correspondents. As an input to building scenarios, the drivers were extrapolated to 2015 using the following scheme:

Each driver was presented in a common framework, involving (a) a brief explanation of the salience of the issue, and an account of the major features it involves; (b) a set of key questions concerning the set of influences; and (c) three 'Outlooks' concerning possible future development. The Outlooks were intended to represent three distinctive patterns of development along the following lines:

- **Alpha Outlooks** represent a "business as usual" future, in effect an extrapolation of current forces and processes (if not always an extrapolation of trends). Current frameworks and conditions relating to the set of influences are expected here to remain more or less unchanged, or changes that are already planned or in hand are expected to be introduced as scheduled, more or less successfully.
- **Beta Outlooks** consider, in particular, some of the many things that could 'go wrong'. What would be the circumstances under which frameworks might break down without viable replacement, where projects and plans might go amiss? The intention here is to get a handle on counter-trends, reasons why undue optimism might be unfounded, challenges that could well need to be confronted if we do set out on the routes mapped out by the Alpha Outlook. Negative disruptive trends would be assessed here.
- **Delta Outlooks** consider potential changes in direction. The aim here is to go beyond analysis in terms simply of success or failure of the plans and programmes mentioned above. For instance, new goals might emerge, or new frameworks or rules of the game may be established. We are particularly interested in those possibilities that involve more visionary outcomes – especially if these contribute to solutions of major social problems. Positive disruptive trends would be assessed here.

The outlooks are not intended to be predictions, but rather they represent plausible outcomes. Needless to say there are many plausible outlooks for each area. Each outlook was captured as a set of bullet points.

3.5 Success scenario workshop

Three baseline scenarios for each region were prepared by the project team on the basis of the driver outlooks. The draft scenarios and drivers formed the main inputs for the Success Scenario Workshop. These can be found in the Supporting Documentation (see Annex 3) or downloaded from the project web site.

As for the scenario workshop itself, the process is summarised in Figure 2. In summary, the workshop began with presentations from the project team and officials from the EC's INCO Unit. These set the background for the workshop, explaining the relevance of the project and highlighting the objectives of the workshop.

The regions covered by SCOPE 2015 are sufficiently diverse to deserve distinct attention. With this in mind, around two-thirds of workshop time was spent working in regional groups. Plenary sessions were interspersed throughout the workshop to allow for cross-fertilisation of ideas. To allow for comparability and cross-fertilisation, a common process (with common questions) was used across all regional sub-groups. Accordingly, a set of semi-structured questions were elaborated for participants to engage with – see below.

Workshop participants had previously been sent the Regional Synthesis Report for their region and were expected to have read this before arriving at the workshop. Following the opening plenary session, three regional Baseline Scenarios were presented to participants in their sub-groups. To recall, these had been drafted for each region on the basis of the Regional Synthesis Reports. Participants were asked to think about the following questions:

- Do the scenarios make sense? Are they plausible?
- Is there anything you would like to add to any of the scenarios?
- What do you think is the likelihood that any of the scenarios will come about?
- What form could international RTDI cooperation take in each of the scenarios?
- What sorts of S&T priority areas could international RTDI cooperation focus upon in each of the scenarios?

After thinking about these questions, participants were asked to think about current RTDI cooperation policy with Europe. Specifically, they were asked to consider the following questions:

- How appropriate are current EU and Partner Country RTDI cooperation priorities and strategies in these different imaginary worlds? Are they readily adaptable to the differing conditions?
- What vision for RTDI cooperation with Europe would be desirable in each of the different scenarios? What sorts of mechanisms would be most appropriate and which S&T areas should be focused upon? What would be the benefits of such cooperation?

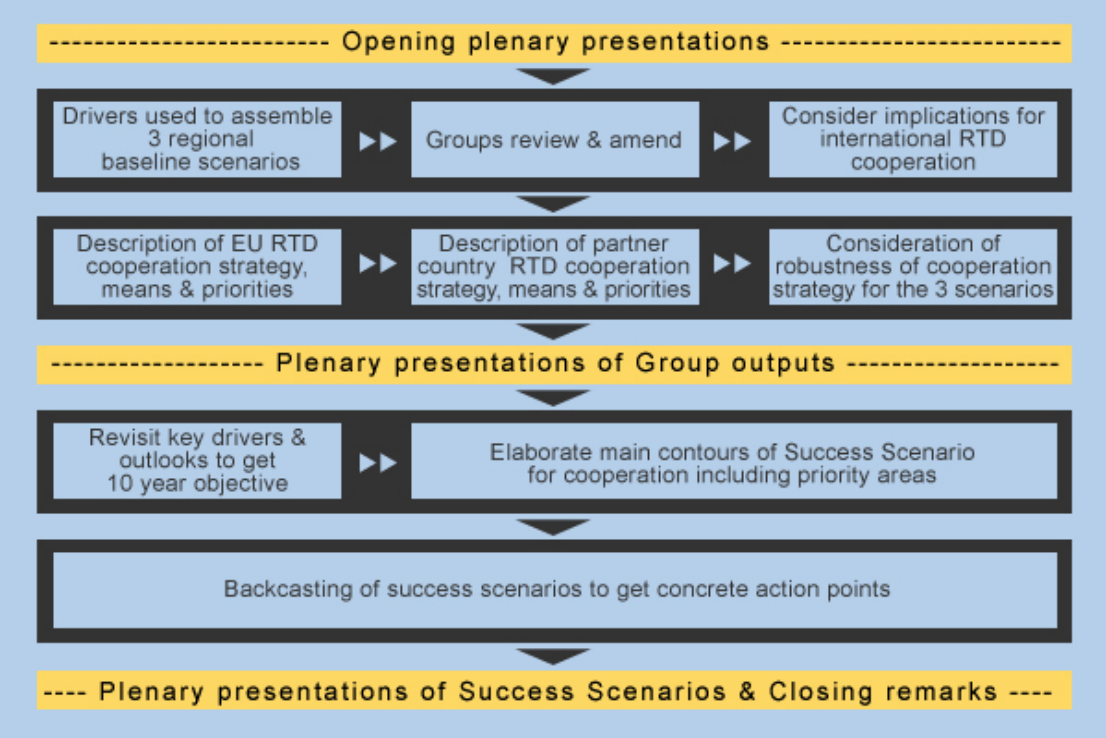
On the following day, regional sub-group facilitators made short presentations to the plenary on the findings thus far. This allowed for ideas-sharing between the four sub-groups. Thereafter, the sub-groups continued with their work, revisiting each of the regional key drivers and outlooks (outlined in the Regional Synthesis Report), with a view to identifying a desirable, yet plausible, long-term (10 years) development objective for each. On this basis, and taking into account the results from the previous day, regional sub-groups began the process of elaborating their Success Scenarios. These set out a vision of future RTDI cooperation as well as a set of action points for its achievement.

Ian Miles has described the success scenario approach in terms of two elements:

- Desirability: capturing a vision of what could be achieved or aspired to by the sponsoring organisation or the wider community that it represents;
- Credibility: the scenario is developed with the assistance of, and validated by a sample of experts in the area chosen to reflect a broad range of interests and usually including both practitioners and researchers.

It is an action based approach, with the shared vision among senior stakeholders of what success in the area would look like being specified in terms of goals and indicators which begin the process of developing a road-map to get there. The purpose of having such a vision of success is to set a 'stretch target' for all the stakeholders. The discussion and debate involved develops mutual understanding and a common platform of knowledge that helps to align the actors for action.

Figure 2: Outline of scenario workshop process



3.6 Policy options workshop

This final workshop functioned as both a dissemination vehicle and as a means of getting feedback, improvement and ultimately buy-in to the policy recommendations. It saw the policy and programme measures suggested in the regional Success Scenarios being debated and discussed. Representatives from several Directorates of the EC took part, along with participants from other intergovernmental organisations, EU Member States, and cooperation partner countries. The workshop was interactive, with participants actively working towards the formulation of concrete steps for improved RTDI cooperation between Europe and the four regions under consideration.

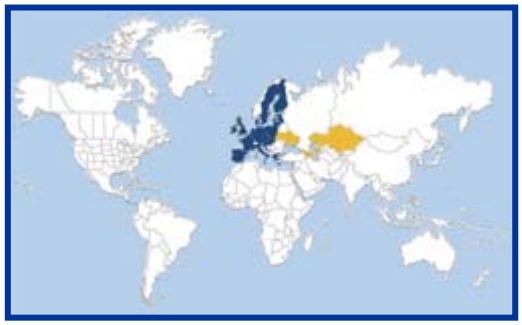
4. Regional findings

In this section, we report the main results that have emerged from the project. Given the diversity between the regions examined, each is reported separately. For each region, some background information on the RTDI landscape is first given. This is followed by a description of the main trends and drivers that are likely to have a significant influence on RTDI developments over the coming decade. Possible futures for RTDI in each region, as captured by the baseline scenarios articulated in the project, are then briefly described. Next, the aspirational "Success Scenario" is summarised, followed by a discussion of the Action Points for further consideration by the European Commission, the EU Member States, the national governments in the region, and other international agencies with an interest in RTDI.

Finally, the broad areas of S&T where cooperation between the EU and the region might prove fruitful in the future are outlined. These represent broad areas of opportunity, since the project could not focus upon the identification of detailed future S&T areas of work. To identify such future opportunities would have required a series of S&T foresight exercises to be carried out in each of the countries covered by the project – clearly, something that was well beyond the remit of the project and would in any case be superseded in terms of detail through scientific and technological advances in the intervening period.

One final point: the regional descriptions provided below are very much summaries of the project's findings. If the reader is interested in learning more about the project's results and analyses, s(he) is recommended to consult the original Supporting Documentation, which can be freely downloaded from the SCOPE 2015 web site.

4.1 CIS region



This part of the study covered four countries in the region, Ukraine, Kazakhstan, Azerbaijan and Georgia. In each of them, national scientific systems, formed for the most part back in Soviet times, have been degraded since the fall of communism and struggle to be relevant in the new environment. Links between economic policy and science and technology policy are weak, with the economy more than ever focused upon basic production industries that make few demands on developments in science and technology.

Given these developments, investment in equipment and supplies for conducting R&D has been cut, leading to the erosion of research infrastructure and a decline in research activity. Less than half the S&T jobs that existed in 1990 remain in 2005, whilst much of the best talent has left the region to find employment in the

West. The average age of R&D personnel continues to increase as young people reject the poor pay and working conditions on offer in favour of jobs in other, more lucrative, parts of the economy.

Meanwhile, Western countries, especially the US and the EU, have been active in trying to shore up S&T systems in the region, providing hundreds of millions of Euros over the last decade or so. The initial focus of this support was on neutralising the threat of weapons proliferation. However, as this threat has subsided, recent cooperation strategy has taken more seriously the challenge of linking RTDI activities to industrial applications. This remains a major challenge, particularly as most companies show little interest in indigenous RTDI and governments have largely failed to provide incentives for them to do so.

4.1.1 Main trends and drivers

Eight main trends and drivers with a likely high impact on future RTDI developments were identified and alpha, beta, and delta outlooks developed for each. Here, each driver is briefly summarised. The CIS Regional Synthesis Report – appended in the Supporting Documents and available on the project web site – provides a full elaboration of each of the drivers, including their outlooks.

1. Governance
In many of the countries of the region, institutions and thus governance are weakly developed and/or in need of reform. Corruption and clientelism remain significant problems whilst at the same time, 'business' interests often dominate national and regional governments. RTDI are not immune to these environmental conditions.

2. Globalisation
Globalisation applies to many areas, including the economy and science and technology. The region has yet to benefit as much as it could from economic globalisation, with relatively little FDI pouring in for example. But it is quite possible that this will change over the coming decade. As for S&T, this is becoming ever more globalised – partly as a direct result of deliberate efforts by governments to jointly tackle large-scale issues together, but also as a result of communities of scientists finding common areas of interest for collaboration. How the region's scientists will plug into these global knowledge communities remains uncertain.

3. Soviet institutional legacy and lack of funding for S&T
The RTDI systems in the region still preserve the main features of the Soviet system: the division between Academician, branch, factory and university sectors; the domination of strict hierarchical structures; and the decisive role of the state in formulating S&T policy. Insufficient resource allocated to RTDI has resulted in obsolete equipment, a gradual reduction in the number of researchers, and the collapse of many branch (industrial) research institutes. The need to overhaul the system of RTDI funding based on implementation of comprehensive funding mechanisms, competitive selection of scientific projects, and selective use of sources of funding, has become increasingly urgent.

Whether reform processes will take place, their nature and extent, as well as their timing, remain uncertain, yet are likely to be decisive for the health of the S&T system over the coming decade.

4. Economic transition and connection of S&T to the economy

Since the fall of communism, science has rarely been viewed as a national priority. Those parts of the science base that were directly connected to the economy, for example, the branch institutes, have been gradually weakened as industrial demand for S&T has declined. Much of the science that is carried out is far removed from an innovation agenda. It is possible that this might change over the coming decade, but a shift in government policy will be required – where S&T are seen as important drivers for sustainable growth – for this to happen.

5. Education and human resources

Poor working conditions, low salaries, and the explicit marginalisation of RTDI have seen the scientific workforce slashed by more than half since 1990. These conditions also serve as a major barrier to attracting young people to scientific careers. Internal and external brain drains mean that scientific human resources are being significantly depleted, leaving a serious question mark over the capacity of S&T communities to reproduce themselves.

6. Technological opportunities

Technological change constitutes an important driver in itself. Future developments in areas such as ICTs, biotechnology, and nanotechnology are likely to lead to profound changes in economies and societies. The extent to which the CIS region will participate in these developments and enjoy their benefits is open to question.

7. Environment and sustainability

During Soviet times, there was little regard for the environment in the race to industrialise. Serious pollution has resulted. Local RTDI could be further directed towards tackling these problems, although economic imperatives might see such efforts sidelined as part of renewed efforts to revive local economies.

8. International RTDI cooperation

Support from the EU and US, through both direct project funding and researcher exchanges, have allowed some scientists in the region to maintain a high scientific standing. Early rationales for this support were focused upon eliminating the threat from weapons proliferation. For the most part, this threat has now been neutralised, so continuing international support is dependent upon the articulation of new rationales, perhaps focused upon wider notions of economic security. Whether the US and EU will vigorously implement cooperation policies to support the development of knowledge economies in the region is open to question. At the same time, close neighbours, China and India, are likely to play an increasingly significant role in supporting S&T in the region.

4.1.2 Possible futures

Three contrasting views of the future of RTDI in the region were articulated in the form of three baseline scenarios. Full versions of these scenarios can be found in the Supporting Documentation and on the project web site. Here, just the main ideas underpinning each of the scenarios are outlined.

Scenario 1 – Islands of excellence
The reform process has been slower than hoped, and efforts to restructure the research system to take on board new priorities are not given sufficient support or resources. However, whilst the majority of scientists in the region are still working within a cash-strapped national framework, a significant number of islands of excellence have emerged that are well supported by funds from home and abroad and that collaborate extensively with international partners. A two-tier system has thus emerged. Most indigenous firms still show little interest in engaging with the science base and instead prefer to source their technology off-the-shelf from abroad. The linkage of science to innovation therefore still remains rather weak.

Scenario 2 – An expense we can't afford
RTDI is not viewed as a national priority for development but rather as a hangover from the past and of little relevance to today. Consequently, it is viewed by many governments in the region as an expense that can no longer be afforded. Many institutions survive in name only and have essentially ceased to function. Those RTDI activities that are ongoing are depleted of resources and disconnected from the latest developments in their fields. Consequently, there is little interest from international partners to collaborate.

Scenario 3 – A science renaissance
CIS countries take their place in the global production and exchange of knowledge, with scientists playing active roles in global knowledge networks. Due to the high skills on offer at internationally competitive rates, several Western research institutes, including universities and private sector labs, invest heavily in facilities and human resources in the region. Other major players, like China and India, follow suit by setting up several joint facilities. This acts as a major spur to the renaissance of science in the region. National priorities for RTDI have been set as part of a national innovation strategy, and these are regularly reviewed to take account of emerging developments. Importantly, budgets for competitive funding are attached to national RTDI priorities, whilst there have also been some major institutional changes.

4.1.3 2015 success scenario: cooperation among Europeans

A full version of the 2015 success scenario can be found in the Supporting Documentation. Here, a summary is provided:

> *In contrast to the situation in 2005, national governments in the region have adopted effective knowledge policies that place innovation at the centre of economic development. This policy shift has been catalysed by*

a number of factors, including: rapid and sustained growth in GDP; emulation of development models offered by the likes of China, India, and Russia; development of knowledge infrastructure partnerships with rapidly developing countries, such as China, India, Brazil, and Russia; and investment in knowledge infrastructures by Western companies looking to outsource some of their R&D activities to cheaper sites of production. Close cooperation with the EU, which put extensive pressure on the governments of the region to adopt more innovation-friendly policies, was also decisive in achieving the shift. The aspirations of some countries in the region for full EU membership, e.g. Ukraine and Georgia, were also instrumental in encouraging them to adopt such knowledge policies.

It was clear that the remnants of the Soviet S&T system were unsuited to the new policy and economic environment, which demanded a leaner, more agile, and better connected S&T system. Several reforms have therefore been put in place with the aim of transforming the governance and organisation of S&T activities. These include: political efforts to engineer the emergence of a national consensus on the strategic role of S&T in socio-economic development; implementation of a consolidation strategy, based upon prioritisation and selectivity, with the aim to strategically focus resources on those areas and institutions likely to provide the greatest benefits; establishment of multi-functional centres of excellence, based largely upon the merger and streamlining of existing institutions; and promotion of greater intra-regional cooperation, with Russia playing a leading role.

All of these developments are viewed positively, but several problems remain, not least the brain drain to the West, which still sees much of the region's best talent leave for better opportunities elsewhere. Also, despite spending increases, the region is still a long way off from meeting the Barcelona Target, with spending on R&D remaining significantly lower than the EU average. This has implications for the state of research labs, which still have some way to go to reach the standards found in the West.

As for international cooperation, the EU has played a pivotal part in achieving many of the positive changes that have taken place. For instance, it has exerted considerable pressure on governments in the region to formulate and implement effective science and innovation policies. This political pressure has been made possible since the EU mainstreamed "knowledge policies" in all its activities, including international relations and its Neighbourhood Policy. Within this context, STI is viewed as playing an important part in helping to secure socio-economic stability in the region. But this pressure has also been coupled to incentives, including the extension to some countries in the region of research and innovation support measures previously restricted to EU Member States. At the same time, the Framework Programme has been actively opened up, meaning that the EC has been much more proactive in promoting participation from the region than in the past. This has involved a number of measures, for example, simplifying FP application procedures, dispatching "knowledge attachés" across the region, and

significantly increasing the amount of two-way mobility of young researchers between the EU and the region.

For all of this to happen, reform could not be confined to the countries in the region. The EU also had to change its ways. This has been manifested in the form of greater joined-up thinking and coordination between the various DGs of the Commission within the framework of "knowledge diplomacy". Greater cooperation and coordination with the support programmes of the Member States and other international agencies has also occurred. Finally, cooperation has been targeted at a multitude of actors in the region, reflecting the EU's belief in supporting systems of innovation rather than just the publicly-funded R&D base.

4.1.4 Actions for consideration

In light of the vision set out in the success scenario, a number of challenges for the coming decade are highlighted here. Practical steps for addressing these challenges are also suggested, although these are initial ideas only and further discussion will be required in order to delineate a comprehensive action plan. Moreover, they address only those actions concerning international RTDI cooperation – there are of course many other actions that could and should be undertaken by national governments in the region independent of an RTDI cooperation agenda.

Challenge 1: Changing mindsets and perspectives on the utility of research and innovation to sustainable socio-economic development
This will take considerable time and imagination to achieve, requiring a long-term commitment from the EC. Various awareness raising approaches, training programmes, exchange visits, and so on should be focused upon changing mindsets, and will have to be targeted at a multitude of actors, including government officials, business people, and researchers. There are of course already some cooperation activities in this area, but these need to be expanded substantially and better coordinated.

Challenge 2: Developing the "knowledge diplomacy" necessary for mainstreaming research and innovation agendas in the European Commission's Neighbourhood Policy
A number of actions are required for this to come about, many internal to the workings of the Commission, but also some that are external, for example, the signing of binding RTDI cooperation agreements with national governments and other actors in the region. Clearly, INCO alone will be unable to enact internal EC mainstreaming actions, but will need to co-opt several allies in other DGs and the Member States in an effort to push through the necessary reforms. But the idea itself, whilst ambitious and certainly for the medium to longer term, should be jointly explored and developed further by several European agencies, and rigorous efforts made to promote it.

Challenge 3: Implementing institutional reform and consolidating research efforts

Much of the onus rests with the national governments in implementing these reforms. However, cooperation actions could include the support of conferences on this subject area, exchange visits, and accounts (demonstrators) of 'best practice' or case examples of institutional reform. The EC should also assess its current cooperation policies and support actions in terms of the contributions they make towards enacting institutional reform and research prioritisation. Where possible and feasible, such cooperation support should be enhanced with a view to promoting implementation of the necessary institutional reforms.

Challenge 4: Promoting innovation through the extension of EU25 policies and programmes to the CIS region

The Commission has been particularly active in promoting innovation across the Member States using a mixture of instruments, ranging from the establishment of a network of Innovation Relay Centres to the provision of "policy intelligence" in the form of the Trend Chart. As part of the Commission's drive towards implementing its "knowledge diplomacy", the whole panoply of innovation support instruments should be considered for rolling out into the CIS region. This will involve close working between various DGs, including DG RTD, DG Enterprise, and DG RELEX. But in the first instance, a feasibility study should be carried out to assess the possibilities for rolling out and adapting the various support instruments.

Challenge 5: Encouraging investment and partnership by the private sector from the EU25

Company decisions on whether to invest or to collaborate in the region are shaped by their perceptions of risks. These include not only the usual market risks, but also risks concerning the upholding of the rule of law and property rights, the threat from political instability and corruption, and so on. Nevertheless, many companies find the risks to be acceptable and go on to invest or partner in the region. The point is that this sort of investment and partnering could be much greater in scale and scope, if only companies in the EU25 were made more aware of the opportunities. There is no quick and easy fix to raising this awareness, and it is something that will need to be addressed in a number of ways over a long period of time. Some of the innovation support measures already suggested in the previous paragraph might help, but other actions are likely to be necessary, no doubt involving other DGs.

Challenge 6: Raising awareness of EU opportunities and improving participation rates by the region's scientists

Although a network on national contact points for the FP does exist in some parts of the region, these tend to be inadequate for promoting participation at the target levels. Moreover, few people in the EC delegations of the region have a comprehensive understanding of the FP and are therefore unsuited to promoting it. Disappointing participation rates in FP6 have led the EC to re-examine its strategy for better involving scientists from third countries. Some radical solutions are almost certainly required to rectify this situation. One suggestion to emerge from the project was for the EC to assign full-time "knowledge attachés" to its delegations, who would support activities such as awareness raising, partnership brokerage, proposal writing, and so on. Such an idea (like the others

in this report) needs to be further discussed and a convincing strategy put in place to ensure much higher participation rates in FP7.

Challenge 7: Building more extensive intra-regional collaborative links
In Soviet times, there were much better links between institutions in the various parts of the CIS than there are today. Until very recently, INTAS insisted that research projects should include participation by centres from at least two countries in the region, but this rule has now been removed. Whilst this condition may have acted as a barrier to the support of some projects, it nevertheless encouraged collaborative working across the region. The reintroduction of this condition should therefore be reconsidered or at least other possibilities for building stronger ties between centres across the region closely examined.

Challenge 8: Achieving greater coordination with the RTDI cooperation activities of other countries and international organisations active in the region
Already, there is cooperation with the US through the STCU, which has recently expanded its operations beyond Ukraine to take in several other CIS countries. But greater coordination with other actors, including the EU Member States and other international organisations, such as the World Bank, is also necessary to maximise the value-added from Commission support. Coordination need not mean joint development of strategies, but could be limited to knowledge sharing on one another's activities in the region. But even achieving this modest coordination is far from easy, especially as information on the various support activities underway is not collected together in one place. Thus, in the first instance, the Commission should discuss with other partner agencies in the region the creation of some sort of data repository that reports on the various programmes and initiatives being carried out. This could be augmented by annual meetings of the main agencies involved where future plans for new initiatives could be set out and presented.

4.1.5 Main S&T areas

The main generic areas where the region has an interest in scientific cooperation include the following:

- Environmental studies and climate studies, including observation of the Earth's surface;
- Physical and mathematical sciences;
- Space and aeronautics;
- Earth sciences and extraction of mineral resources;
- Biomedical research and health protection studies;
- Agricultural research, forestry and fishery studies;
- Industrial technologies;
- Material science and metrology;

- Non-nuclear power engineering;
- Transport;
- Information society technologies;
- Social studies and humanities;
- S&T policy; and
- Training and exchange of specialists.

4.2 Sub-Saharan Africa

This part of the study addressed four countries in detail, Nigeria, Ghana, Kenya and Botswana, and a fifth, Senegal, in part. The general pattern in the post colonial era has been the establishment of ministries and advisory structures. Reorganisation has been quite frequent and some tension exists between the role of science and sectoral ministries on the one hand and the need for coordination on the other.

In general, scientific effort is strongly concentrated in medicine and biomedical research plus biology (covering agriculture). In Nigeria, Ghana and Botswana the government is the main funder of research, while in Senegal almost twice as much comes from external sources and in Kenya an estimate of over 90%. The latter include some bilateral European inputs and quite extensive involvement in multilateral programmes. All countries have a mix of university and institute based research with a very limited role for the private sector. Research spending is well under 1% of GDP. In all cases the setting for S&T policy is a broader vision of national development generally on a foresight timescale of ten or more years. Poverty reduction strategies are also having a strong impact, with agricultural development in particular being promoted. In general the policies are well formulated and comprehensive. Problems lie not here but in implementation.

General concerns in the human resource area include poor pay and conditions, resulting in a serious brain drain problem within the sector to other non-science sectors and abroad to developed countries. Research infrastructure is often in a poor state.

National systems of innovation are generally not well-positioned to take up new technological opportunities, reflecting often poor management structures and basic infrastructure. S&T capacities are weak in terms of human and financial resources and often suffer from poor programming and poor working conditions for researchers. Capacities are non-existent in new technologies such as nanotech. The majority of institutes and research centres are focused in areas of applied research related to basic needs, such as forestry, agriculture. Universities are poorly equipped and still too theoretical in their teaching methods and approaches. Contributing factors are the weak links between industry and

universities and other public RTDI institutions, poor RTDI quality standards and regulatory and mechanisms for RTDI.

In general the balance between external and internal pressures is skewed towards the external – with policies being driven more by the global (FDI and donor countries and agencies) and regional (neighbouring countries) political and economic dynamics. There is insufficient exploitation of the benefits of international cooperation on many levels including support with policy learning, developing institutional and developing technical capacities.

4.2.1 Main trends and drivers

Three main groups of trends and drivers with a likely high impact on future RTDI developments were identified and alpha, beta, and delta outlooks developed for each. Here, each driver is briefly summarised. The Africa Regional Synthesis Report – appended in the Supporting Documents and available on the project web site – provides a full elaboration of each of the drivers, including their outlooks.

The drivers are presented in three groups:

a) Those relating to the broader political, economic and social environment/context;
b) Those relating to the research and innovation system; and
c) Those relating to international cooperation in RTDI.

a) Political, economic and social environment /context

1. Governance and globalisation

Insecurity and a fragile political situation with frequent conflicts is a destabilising backdrop for the whole regional governance structure. Stable governments still suffer spillover effects from neighbouring states. Corruption and clientelism, reinforced by some foreign multinationals, lock decisions about funding and recruitment into old, traditional patterns and networks and prevent network re-alignment and policy change. The lack of transparency in policy structures and closed decision-making processes causes donor countries and agencies often to unwittingly contribute to this vicious circle. International (IMF austerity) and national programmes negatively impact on the resources available for RTDI and result in lack of priority for S&T driven development. Trade restrictions and agricultural subsidies in the West distort markets and in turn give the wrong signals for scientific priorities. Poverty reduction and sustainable development remain key formal priorities dominating the national agenda but without a sound scientific base (grounded in significant investments in RTDI), policy measures remain superficial and lack effectiveness.

2. Education and human resources

Education is seen as the central challenge in developing a knowledge-based economy and society. The entire system needs attention, with basic literacy and numeracy, youth take-up of S&T in schools, and under-investment in tertiary education all being factors. Among the insufficient numbers of qualified people challenges remain in retaining them and in engaging them in relevant

employment. Higher education institutions also provide a key element in incubation strategies. Brain drain is a factor, both to international scientific institutions and to better paid management positions in the private sector. On the positive side the brain drain has created a diaspora which potentially can be networked to the benefit of the countries concerned. However, insufficient opportunities within the country prevent even those who wish to return from productively applying their skills to improve teaching and research capacity. Within the RTDI sector there is also insufficient mobility between institutions and between public and private sectors. In some countries the numbers of highly qualified people is also under threat from HIV/AIDS. In general there is no dedicated strategy in place for strengthening and retaining human resources in S&T.

3. Sustainability

Countries are facing severe problems of maintaining sustainable urban growth, avoidance or reversal of environmental degradation, carbon management and preservation of habitats. Sustainability has emerged as a key priority for the RTD efforts of nations and national science academies in sub-Saharan Africa. Thus formal S&T priorities include optimising on the sustainable use of the natural resources of the country. The general thrust is to achieve multi-sectoral synergies between governments, international organizations and the private sector towards sustainable development. The scientific community is seeking to promote the widespread use of existing knowledge to develop environmentally-friendly/sustainable technologies and practices. However, it is not clear that governments have accepted the fact that the transition towards sustainable development is dependent on considerable investments in science, research and technology.

b) Research and innovation system

4. Governance of science and innovation

All of the countries concerned have experienced at least the rhetoric of having science at the core of the national development vision but all also raise concerns about the lack of real political commitment and interest in science and innovation. The weak linkage between the scientific and political communities plays a key factor rooted in diverging interests and priorities. This is reflected in low budget levels as a proportion of GDP and in structural terms the persistence of some outdated institutional structures for science. Low budgets impact particularly on infrastructure, including access to scientific information. Also constrained is the ability to shift activity in the direction of newly identified priorities. At a high level the problem is partly attributable to lack of engagement of scientific advice across a range of policy issues, while at a lower level insufficient numbers of high quality scientific managers create a constraint. The engagement of citizens in scientific issues is also an issue.

5. Connection of science and technology to the economy

The private sector has not in general invested significant amounts either in performing its own R&D or in placing contracts with public sector research institutions or universities. As a result technology generally comes from abroad in packaged form excluding even the possibility of adaptive R&D. To some extent

local branches of multinational companies place contracts with research institutions and universities but these are not large in relation to overall budgets and are often one-off investments with limited repeat possibilities. A series of measures are possible to create a dynamic innovation system including support for the creation and development of innovative small and medium sized firms, including use of incubators and technology parks, use of public procurement for innovation, and stimulation of the emergence of a venture capital sector.

6. Technological opportunities

Priorities for science and technology and the opportunities presented by developments in key fields can themselves be seen as drivers for RTDI policy and for international cooperation. In the countries covered current research is dominated by the agricultural sector though most areas are represented to some degree. Policy priorities for future development include:

- Modernisation of agricultural production and agri-processing;
- Food security and sustainable management of natural resources;
- Health –including research on public health and on endemic, emerging and communicable diseases;
- Development of the information society;
- Access to energy;
- Infrastructure, water and sanitation; and
- Seeking to maximise commercial exploitation of local raw materials.

c) International cooperation

7. Donor strategy

All of the countries depend on support from multiple donors, operating both bilaterally and multilaterally. National funding tends to be committed to salaries and basic institutional costs. Donors provide funding, some logistical inputs and some sponsorship of training. This gives them a strong influence over the content and direction of research. The real motives of donors are often not transparent and are not screened carefully enough before decisions are taken on research direction. In the short run these inputs are beneficial, even essential, but there are concerns about long-run dependency and reactive rather than proactive policymaking. Further concerns raised are that funding of this kind prevents the country from developing its own "joined-up" strategy for science, technology and innovation because each project is an opportunistic response to different donor strategies. Efforts are thus often fragmented and not sustained beyond the lifetime of the projects. Benefits of international cooperation are insufficiently exploited on many levels, including lack of opportunity for policy learning, and developing institutional and technical capacities.

8. Scientific diplomacy

There are multiple motivations for developed countries to engage in scientific cooperation with developing and developed regions. At a high level "scientific diplomacy" can be seen as a means of pursuing broader foreign policy goals including promotion of growth, democracy and stability in neighbouring regions and as one dimension of integration into the world economy. More specifically, cooperation strategies can serve broader goals such as dealing with global environmental, food security or health-related issues. Gaining access to unique

sites, facilities or population groups can be necessary for certain areas of science to progress and provides the basis for many North-South joint research projects. This can be positive for example in terms of focussing research on diseases prevalent in developing countries, or negative, for example in terms of asserting ownership of intellectual property in traditional remedies or natural substances. The broader spectrum of scientific diplomacy is becoming more complicated as new actors such as China, Korea and India engage in bilateral alliances with African countries, usually with a product development focus. Deciding on the balance of relations with developing and developed regions is not easy. The role for intra-regional collaboration also needs to be articulated.

4.2.2 Possible futures

Three contrasting views of the future of RTDI in the region were articulated in the form of three baseline scenarios. Full versions of these scenarios can be found in the Supporting Documentation and on the project web site. Here, just the main ideas underpinning each of the scenarios are outlined.

Scenario 1 - Implementation gap
The political system remains in place but governance is under strain, with visions over-shadowed by global pressures. A key resource constraint is the supply of trained people with migration a key problem. A mix of good and bad RTDI policies are drafted but left on the drawing board and not implemented due to lack of resources. Private sector engagement is far too limited and not supported. There is no coordinated approach to sustainability with donors calling the tune and donor strategies crowding out a joined-up national approach. The importance of science is recognised but not implemented.

Scenario 2 - Cast into the wilderness
Governance is stretched to its limit and the political response is a focus on short-term populist measures. While these are not effective, they consume political attention and money. RDI policy debate and implementation are off the agenda. An inevitable consequence is a declining infrastructure and demoralised scientific workforce. Also fatally hampered by lack of time and facilities is the ability of science to engage with industry with industry walking away from innovation. Sustainability is regarded as a constraint to growth and poverty reduction and donors switch away from science. Where scientific cooperation persists its main rationale is as a counterweight to failures of foreign policy in other dimensions. S&T aid is not integrated with broader aims of promoting economic and social development. Science faces exclusion from any significant national role.

Scenario 3 - We stand connected
Reformed political institutions and more stable economic conditions together with a more proactive stance in relations with IMF and other donor agencies has lead to a major unlocking of resources for RTDI. Reorganisation of national research systems around interdisciplinary problem focussed centres of excellence allows a rapid shift to new technology platforms. A new generation of scientists and managers has emerged from a concerted effort to promote technical education and forms the basis of an entrepreneurial culture. The national or regional strategy forms a natural focus for coordination between donors. A new alignment

of foreign policy and scientific cooperation places the development of knowledge societies at the core of strategies for developing prosperous societies. The new joined-up approach to policy sees science at the centre of government.

4.2.3 2015 success scenario: innovation at the heart of development

A full version of the 2015 success scenario can be found in the Supporting Documentation. Here, a summary is provided:

New governance for Science and Innovation:
A background of economic and political stability sees the emergence of new, highly connected research and innovation systems, with commitment from the highest levels of government. A widely shared national vision has been put in place with research and innovation driven from the centre of government. An indigenous model for research and innovation has emerged, known widely as the African Research and Innovation System (ARIS). The core themes are developing and exploiting human potential, engagement with the economy and society and a new governance emphasising linkage and high level commitment.

New priorities to engage S&T with the economy and society
Success in 2015 sees:

- *Successive waves of policies implemented that re-orient the research and innovation system.*
- *Re-launched research and innovation agenda*
  - *Generic infrastructure and basic needs addressed*
  - *Building capability for entrepreneurial activity*
  - *Next generation technologies*
- *Smart networking and institution-building*

In terms of developing and exploiting human potential, Success in 2015 sees

- *A focus on education and a change to a problem-based learning system.*
- *Human potential driven by education at all levels*
- *At the tertiary level major changes were made towards a problem-based learning system.*
- *Strong incentives are also provided for the Faculty to engage with the economy and society.*
- *Work-ready graduates and shift in the balance of recruitment in favour of science and engineering.*

Understanding industry's needs
It had been recognised that policy for engagement of science with industry had to address three separate target groups:

- *Multinationals and FDI's engaging with the local innovation system to provide a link to the global knowledge economy.*

- *Traditional Firms working through associations to access new technologies.*
- *Start-ups as the biggest growth sector, emerging from the new entrepreneurial culture.*

Partnership driving international cooperation agenda

- *International cooperation driven from national and regional strategies which allow equitable and mutually beneficial partnership with the EU.*
- *Partners not donors.*
- *Research and innovation connected through cooperation.*
- *Regional networks and a Euro-Africa Research Area providing a framework for cooperation.*

4.2.4 Actions for consideration

In light of the vision set out in the success scenario, a number of challenges for the coming decade are highlighted here. Practical steps for addressing these challenges are also suggested, although these are initial ideas only and further discussion will be required in order to delineate a comprehensive action plan. Moreover, they address only those actions concerning international RTDI cooperation – there are of course many other actions that could and should be undertaken by national governments in the region independent of an RTDI cooperation agenda.

Challenge 1: Africazone RTDI scoreboard or trendchart

The process of ensuring that policy visions are actualised and plans developed and put into implementation can be addressed through the development of RTDI indicators to track progress in addressing milestones and targets. In EU-25 this process is promoted through the Innovation Trendchart and European Innovation Survey statistics. A process for covering the Medzone has now also been launched and a similar initiative covering Africazone could play an important role as policy lever by benchmarking progress in African countries.

Challenge 2: Introduction of RTDI cohesion plan (modelled on experiences in EU) to address regional disparities and assist weaker regions

The emphasis under this challenge is on capacity building. Working with a redirected tertiary education system support is focussed on Centres of Excellence which demonstrate what can be achieved and act as a brake upon the tendency for brain drain.

Challenge 3: Triangular research partnerships

The traditional INCO mode of cooperation focused on a particular region could be reviewed to allow for and encourage more inter-regional cooperation and partnerships. A particular avenue to be explored in this respect are triangular partnerships involving partners in Africa, Maghreb and EU, aimed at promoting a better understanding of needs and institute linkages.

Challenge 4: Using FDI and multinationals to build the regional innovation system
A partnership with large European firms can provide the basis for a concerted action to engage these firms with the regional innovation system. Sponsorship of targeted education initiatives and efforts to employ local staff in a technical capacity will provide the mutual benefit of expanding the human potential available to these companies and providing the core of clusters from which indigenous firms can develop and enter the knowledge based supply chain.

Challenge 5: Support for start-ups, young entrepreneurs and entrepreneurial universities but within a coherent national/regional innovation strategy that is relevant to social and economic needs
Universities are at present largely disconnected from the entrepreneurial sectors. Following the success scenario, the incorporation of problem-based learning in the technological and managerial curricula will provide a core from which an entrepreneurial culture can emerge.

Challenge 6: Framework Programme National Contact Points for Africa
Support could be provided to African countries to set up their National Contact Points for the EU Framework Programme. This would help to ensure that opportunities open to African partners are more widely disseminated in a timely manner and fully exploited. It would also help to ensure an improved channelling of EU Framework Programme and other funds so that they reach scientists and researchers more directly.

Challenge 7: Awareness-raising on importance of science and engineering investments to address basic needs and as vital in all policy areas
While progress has been made in the past year there is still a tendency to marginalise the role of science when addressing core national and regional problems. For example, it is important to have a clear reference to the contribution of research and innovation in the Poverty Reduction Strategy Papers.

Challenge 8: Support for skills development in science policy management and policy design in government
Young researchers and policy-makers from African countries can be provided with targeted support to participate in science policy and R&D management programmes in Europe. This could in turn open up opportunities for participation by relevant African organisations in Framework Programme RTDI policy-related projects. Era-nets targeting RTDI policy coordination could also be encouraged.

4.2.5 Main S&T areas

The main generic areas where the region has an interest in scientific cooperation include the following:

THEMATIC PRIORITIES
The following short-term and medium-term priorities for cooperation were identified:

Immediate/ short-term

- Health care including Commercialisation of African traditional medicines and plant based products
- Endogenous technology in agriculture, solar energy
- ICT development and diffusion

Medium-term

- Energy efficiency and saving and photovoltaics
- Socially friendly technologies
- ICT – hardware development
- Materials
- Ecological systems and climate research
- Value added products from agriculture
- Spatial analysis, geomatics and environmental sensors
- Development of biotech with adequate safeguards

4.3 Maghreb and Mashreq

Although this study directly concerns three countries from the Maghreb and Mashreq regions of North Africa – Morocco, Tunisian and Jordan – the regional synthesis report puts these into the broader context of the **MEDA Partnership**[1] with its associated **Barcelona Process** and the more recent **Wider Neighbourhood Policy**.

The most salient aspect of the MEDA partnership is a commitment to the creation of a Euro-Mediterranean Free Trade Zone by 2010. Peace and prosperity in the region is vital for the security of Europe. The region faces considerable challenges not only in terms of security and social harmony but also in terms of business development and new job creation. Recent progress in the privatisation of state industry, the modernisation of investment related legislation and structural reform of major industrial sectors has created the conditions for increased flows of foreign direct investment to the region. European investment in the region has become increasingly technology intensive. This testifies to the quality of the MEDA work-force and underlines the role of MEDA companies as partners in European industrial supply chains. As European industry respond to the challenge of increased competition and the effects of global trade liberalisation, supply chain partners in the MEDA states adjust accordingly. By World Bank estimates

[1] The MEDA partnership originally referred to a group of twelve countries comprising Algeria, Cyprus, Egypt, Israel, Jordan, Lebanon, Malta, Morocco, Palestine, Syria, Turkey and Tunisia. Cyprus and Malta are now member states. Turkey has started on the path to accession and Israel stands apart as a developed economy with a very strong science base and excellent global reputation in research and innovation. Both Turkey and Israel contribute to the budget of the Framework Programme and participate on an equal footing as EU member states.

the eight Arabic speaking countries of the MEDA Partnership need to create almost 40 Million jobs in the period 2000 to 2010. Many of these jobs will be smart jobs suitable for graduates in areas such as engineering science and technology.

Regional expenditure on research is very low. Investment in research by private companies in the region is almost non-existent. Some MEDA governments have started to address issues related to innovation and the role of science, technology and engineering in economic growth. A local venture capital industry has started to emerge. The first incubators and technology parks are now being established in the region. It is possible in principle for research institutions based in MEDA partner states to participate in the **Framework Programme** and budget has been set aside to finance their participation in projects under the EC Framework programme. In reality however it has been very difficult for MEDA institutions to cooperate on this basis. They lack critical mass in terms of their research activities, they lack opportunities to develop the relationships essential for building research collaboration and they lack the image of excellence that is essential for participation in consortia that must compete fiercely for the funding of projects they propose. Although the **MEDA Association Agreements** refer to cooperation in research, very little has been done so far to support Euro-Mediterranean cooperation in RTD and Innovation on the basis of **MEDA Programme** funds.

4.3.1 Main trends and drivers

13 main trends and drivers with a likely high impact on future RTDI developments were identified and alpha, beta, and delta outlooks developed for each. Here, each driver is briefly summarised. The MEDA Regional Synthesis Report – appended in the Supporting Documents and available on the project web site – provides a full elaboration of each of the drivers, including their outlooks.

Trend 1 - The privatisation of state industry
Changes such as these are accompanied by the introduction of modern management methods including management processes for goal setting and planning based on clear strategic vision. They are accompanied by improvements to the overall business environment, the development of new knowledge intensive business sectors such as advertising, business consulting and financial services. They are accompanied by the development of civil society structures intended to represent the needs of small and medium sized industry. One of the important challenges for the future will be the orientation of research in line with the needs of industrial restructuring.

Trend 2 - Emerging innovation policies and measures
Morocco, Tunisia and Jordan have started to formulate explicit innovation policies and programmes. In this area they are ahead of the other countries in the region. Activities to benchmark innovation policy using the European Innovation Trend Chart and Innovation Scoreboard could help these countries in their policy learning process and encourage other member of the partnership to take action in this domain.

Trend 3 - Growth in the occurrence of hi-tech FDI
The ANIMA[2] network runs MIPO, the Mediterranean Innovation Project Observatory, and monitors investments in the region. Most investment activity is linked to the privatisation of state industry, and to traditional sectors such as tourism, retail and construction. Nevertheless there is a noticeable trend in hi-tech investment. These have occurred in areas such as micro-electronics, precision engineering and medicine. FDI agencies in the region now wonder if it is possible to brand the region as a 'smart region'.

Driver 1 - The Barcelona process
In fairness this is not a driver of policy in the area of science, technology or engineering, though it should be, in view of the fact that it is referred to in the Association Agreements. The MEDA Programme however does make substantial contributions in areas such as education and training as well as to the upgrading of industry in the region. Research has an important role in education as well as in company strategy. Perhaps this could be a way to put it on the agenda for partnership.

Driver 2 - The job creation challenge
World Bank statistics indicate that almost 40 million new jobs need to be created in the region in the period 2000 to2020. Addressing this issue will require a whole new way of thinking about the economy.

Driver 3 - International trade liberalisation
All countries of the MEDA partnership feel the forces of competition from countries such as Romania and China.

Driver 4 - Knowledge and human resource needs of industry
The MED-BEST reports elaborated for each MEDA partner country with support of the European Commission inevitably refer to the gap between educational qualifications and the needs of industry. The knowledge and human resource needs of industry should be drivers of the research system, but they are not! The problem is three-fold:

- The inability of industry to understand and articulate its needs,
- The lack of a platform where industry and academia can discuss these issues,
- The lack of resources to make the necessary changes.

Driver 5 - Investment in research and higher education
Investment is low and in most cases does not come close to 1% of GERD. Almost all of this is public sector investment. The private sector buys technology but does not invest. The public sector is making efforts to increase investment but private sector management lacks the culture and the know-how to use science and technology as a factor of competitiveness.

Driver 6 - Policy processes such as Foresight, evaluation, benchmarking and policy- related research
Morocco, Jordan and Tunisia have all carried out major foresight exercises. It looks as though these tools will continue to be used as part of policy development

[2] www.animaweb.org

process. They are drivers for change but their use is confined to small groups close to central government. A broader uptake of these planning tools could accelerate change at regional and sectoral level as well.

Driver 7 - Supply chain strategies and the restructuring of industry
Observing patterns of investment in the region MEDA partners are important components in European supply chains. This is not confined to sectors such as agriculture, textiles and clothing or tourism, but to micro-electronics, software development and precision engineering and architectures as well. Investing in MEDA research is an investment in European industry through their supply chain partners and subsidiaries. This should be a driver of science and technology policy but it does not yet appear on the policy radar. European investments in MEDA states are eventual clients of the MEDA science system.

Driver 8 - Emerging innovation policy
To varying degrees all MEDA countries have made some progress in terms of the development of a dedicated Innovation infrastructure. It is early days yet but the presence of venture capitalists, incubators and the development of science parks have added new voices to the policy debate. Nevertheless those involved in research need to clarify their role in the innovation economy. Some universities and technical engineering schools have started to introduce course on innovation as a separate subject.

Driver 9 - Leadership and grand challenges of the region
The region possesses a number of unique assets in terms of arid zone plants that may have medicinal or cosmetic or other commercial value. However little has been done to build upon this. It also shares stewardship of the Mediterranean Sea with Europe and suffers considerably from a shortage of water and an excess of sun. It also has unique deposits of basic chemicals such as phosphates, oil, gas and unexploited oil-shale.

Driver 10 - National programme priorities
Clearly funding programmes have a considerable influence on research that can be conducted. If it is not financed it can't happen.

4.3.2 Possible futures

Three contrasting views of the future of RTDI in the region were articulated in the form of three baseline scenarios. Full versions of these scenarios can be found in the Supporting Documentation and on the project web site. Here, just the main ideas underpinning each of the scenarios are outlined.

Scenario 1 - The gazelle gets lucky but maybe a little fat
Some economies such as Morocco followed closely by Tunisia and then Jordan move on to another level of performance based on investor friendly policies, trade-liberalisation and attention to the development of human capital and modern knowledge infrastructure. Progress however is slow. Things improve but the political will and investments required to make a significant short and medium term impact are not realised. Other countries in the region remain unconvinced.

Scenario 2 – The gazelle runs forever from the lions
There is widespread apathy concerning the Barcelona process and opportunities provided by the MEDA and Wider neighbourhood programmes are ignored missed.

Scenario 3 - This is one mean gazelle, the lions had better watch out!
The penny drops! All MEDA partners now understand that science, technology and engineering are essential to growth and prosperity. The full weight of the state gets behind the knowledge and innovation agenda. The region emerges as a leader in issues related to water, energy, the environment as well as the biology and bio-technology of arid-zone plant-life.

4.3.3 2015 success scenario: let's create prosperity!

A full version of the 2015 success scenario can be found in the Supporting Documentation.

MEDA Governments clearly adopt policies reflecting that:

- *Sustainable capabilities for value creation are KNOWLEDGE based rather than RESOURCE based.*
- *It is important to encourage INVESTMENT in knowledge intensive industries and to fully participate in international markets for goods and services.*
- *Priority areas requiring government SUPPORT include research, innovation, education and entrepreneurship.*
- *These areas for investment are INTERLINKED and good policy development requires a high level of communication between government MINISTRIES and with major STAKEHOLDERS from industry academia and civil society.*

The industrial structure of MEDA countries has changed considerably over the last two decades:

- *MEDA production systems modernize and move up the value chain.*
- *The privatization of state run companies provided an injection of foreign capital and management know-how, as well as access to international business networks.*
- *Employment has been created in sectors entirely new to the region including business process outsourcing, the design and development of microelectronic systems as well as bioscience based industries such as production of vaccines and pharmaceuticals.*

The region hosts the focal point of a knowledge based Euro-Mediterranean bio-economy that touches upon natural oils and high value molecules for food, food ingredients, medicine, cosmetics, and other plant-factory based production systems.

The research and higher level education systems
MEDA partners now possess high quality systems for research and higher education that are excellent in niches corresponding to comparative

advantages of the region. These systems are integrated regionally and with the EU on the basis of programmes for:

- *The mobility of students,*
- *The professional development of research and teaching staff,*
- *The planning and realization of joint-research projects.*

They are integrated with their own national innovation systems in terms of access to facilities for incubation and services for enterprise development, as well as seed, start-up and growth capital.

The evaluation of research in higher education takes account both of its contribution to industrial problem solving and new knowledge creation, of its contribution to the professional development of staff and to the acquisition of advanced knowledge skills by students. Considerable progress has been made to reduce bureaucracy associated with budgets assigned to faculties and individual research laboratories.

The governance of Science and Technology
All MEDA governments routinely publish and regularly revise national policies for higher education, research, innovation, entrepreneurships and new business development. These are developed on the basis of wide-spread consultation with all major stakeholders.

Alignment with needs of industry
The universities play an active role in helping employers to better understand their human resource requirements. They play a key role in the organization of fora on skills and human resource requirements for the modern economy. Industry and civil society with the support of government plays a key role in DRIVING this DIALOGUE.

4.3.4 Actions for consideration

In light of the vision set out in the success scenario, a number of challenges for the coming decade are highlighted here. Practical steps for addressing these challenges are also suggested, although these are initial ideas only and further discussion will be required in order to delineate a comprehensive action plan. Moreover, they address only those actions concerning international RTDI cooperation – there are of course many other actions that could and should be undertaken by national governments in the region independent of an RTDI cooperation agenda.

Challenge 1: INCO preparatory actions to leverage sources of structural funding
Although the **MEDA association agreements** refer to cooperation in research, very little has been done so far to support Euro-Mediterranean cooperation in RTD and Innovation on the basis of **MEDA programme** funds. The INCO part of the European Commission Framework Programme should support actions intended to leverage MEDA funds for the development of world class knowledge infrastructure in the region. This would enable institutions in the region to participate in the Framework Programme on an equitable basis with EU partners.

It would provide a basis for integration with the ERA. It would develop unique resources of the region, bringing benefits to Europe as well as to the MEDA partnership. The strategy is to finance preparatory actions under INCO that build the partnership and cement political will across the region for structural initiatives that could be financed on the basis of the MEDA or Wider Neighbourhood programmes, as well as by the Programmes of other development agencies such as the World Bank, the EBRD and the UNDP.

Challenge 2: Triangulation initiatives with the African continent
MEDA partner states such as Morocco host considerable numbers of students from Africa. Morocco alone host more students from sub-Saharan Africa that the whole of Europe put together. This provides Morocco and indeed most MEDA partners with access to a unique pool of talent from African nations as well as institutional links with universities and research laboratories throughout the African continent. Opportunities for networking, for student and staff mobility as well as collaborative research on African issues involving teams in sub-Saharan Africa, the MEDA partner states and the EU would bring benefits to Europe, Africa and the MEDA in terms of ERA integration, access to global talent and collaboration with teams that would be otherwise hard to reach. Initiatives such as these would make a significant contribution to achieving UN MDG VI - Global Partnership for Development.

Challenge 3: Meeting grand challenges
Cooperation on the grand challenges of society for example on:
- The environment and climate change.
- The management of shared resources such as Mediterranean sea.

Challenge 4: Cooperation on 'Mobility'
Taken in the broadest sense of the term, for example on:
- Public health issues such as global pandemics, strategies for containment and the economics of large scale treatment.
- The negotiated migration of workers – status, control, and cooperation between authorities.

Challenge 5: Engaging with emerging technologies
Cooperation in all areas mentioned in the next section will give substance to the MEDA Partnership in terms of cooperation in RTD and Innovation. As shown in the note that comes after it, cooperation in specific areas such as **nanotechnologies** and **biotechnologies** are not only of importance for the medium and long-term needs of modern industry, but they provide an opportunity to address a number of the **Millennium Development Goals**.

4.3.5 Main S&T areas

Research must be ever more closely linked to the needs of the economy. RTD priorities include areas intended to develop the unique assets and comparative advantage of the region. Such priority areas for research include:

- Aromatic and medical plants of arid zones their biology, genetics, biotechnology and application in medicine, cosmetics and other areas of importance to the economy.

- Energy from the sun, wind and sea, oil-shale and other sources, generation, distribution, efficiency and management.
- Water – its generation, distribution, sustainable management and treatment for urban and rural environments, for living, tourism, industry, agriculture and other contexts.
- The monitoring, management and sustainable development of marine resources and marine bio-prospecting.
- The sustainable development of extractive industries (such as phosphates) and their down stream industry sectors.

Another area of importance for the creation of prosperity in the MEDA region is research linked to the new emerging market context of the MEDA partnership and the Euro-Mediterranean Free-Trade Zone. This includes research related to:

- Re-structuring of MEDA economies.
- Integration of Euro-MEDA production systems.

Research is also needed in cross-cutting areas and enabling disciplines. This will ensure a relevant skill base and to enable innovation based on local excellence and access to global excellence in important emerging domains such as:

- Information Society Technologies.
- Molecular sciences, engineering and medicine.
- Nanotechnology (see Annex4).
- Intelligent Materials.

4.4 Latin America

National scientific systems in Latin America began to show some shape only after the 1970s. Such emergence is a consequence of the small but exponential process of economic, social and cultural transformation that took place in the region during the 1950s and 1960s, some of which include: population increase; national policies of import substitution, speedy industrialisation and urbanisation; and large investments in higher education.

During those years UNESCO and the Economic Commission for Latin America (ECLAC) played an important role in the promotion of Science and Technology initiatives similar to that of European leading economies, that is, supporting the creation of S&T and Research Councils and encouraging countries to raise investments in science and technology to 1% of their GDP. On the latter goal, perhaps it is worth noting that today that target is still, surprisingly, proposed but for 2010 or 2015. While Europe and other developed and dynamic economies allocate between 2 and 3 percent of their GDP to investments in research and development, only Brazil, Cuba and Costa Rica have reached 1%. Over the last 10 years the regional figures have been oscillating between 0.2% and 0.7% of GDP. In terms of S&T financing during the last 12 years, expenditure in most countries is provided mainly by governments, followed by the higher education sector and enterprises. From the countries studied, Colombia is the only case where the contribution of enterprises seems to be larger than the government. In terms of the Frascati definitions, Argentina and Colombia focus nearly 50% of their resources on Applied Research, and the remaining 50% is more or less equally distributed between Experimental Development and Basic Research. In Chile the situation is different with 53.3% funding Basic Research, 32.1% for Applied Research and 12.6% for Experimental Development.

In terms of publications, a comparative analysis of S&T publications in 12 selected journals show that Argentina has an outstanding publication capacity and positions itself well above Chile, Venezuela and Colombia. We should point out that each year the total numbers of publications increases – though this is a global phenomenon – and to recognise that in the last 10 years Argentina has managed to double its figures.

In terms of patents, we should emphasize that patent applications are nearly 90% from non-residents, indicating that either foreigners have better research and patent capacity or that patent regulations are more flexible and open to non-residents.

4.4.1 Main trends and drivers

Ten main trends and drivers with a likely high impact on future RTDI developments were identified and alpha, beta, and delta outlooks developed for

each. Here, each driver is briefly summarised. The Latin America Regional Synthesis Report – appended in the Supporting Documents and available on the project web site – provides a full elaboration of each of the drivers, including their outlooks.

1. Governance

Latin America is still experiencing the consequences of privatisation processes (of the 90s mainly) which affected traditional and key industries in some countries (such as telecommunication, energy, transport, and water and electricity companies, among others). As part of the global governance philosophy many countries implemented 'structural adjustment' programmes of the IMF which later on proved to have serious negative consequences in the region, e.g. huge and practically unpayable national debts. It is generally perceived that Latin American industrial capacity and technological capabilities are not yet up to a level for competing on equal terms and conditions imposed by extreme open-market policies. The overall political and economic picture of the Latin American regions has been turbulent, fragile and continuously showing radical changes that directly affect national budgets for RTDI. In this context, governments are making enormous efforts to articulate and integrate major national stakeholders in RTDI into a coherent and nationally coordinated S&T system aimed at the identification of national and regional 'real' priorities. Poverty and exploiting benefits of globalisation with a focus on endogenous development and "fair trade" are seen as key driving forces for the future of the region.

2. Governance of science and innovation

All of the countries concerned are currently experiencing major changes and redefinition of the government role and interest in science, innovation and creation of value. With increasing engagement of citizens in scientific issues becoming a major driving force that encourages and motivates national governments to invest in RTDI (mainly to improve and modernise the outdated institutional structures for science). As part of these, new visions and priorities are emerging based on consensual processes of dialogue between the public, private, academic and the civil society.

3. Globalisation, economy and industrial landscape

The impact of globalisation on the economy and the industrial landscape brings opportunities for the region, from better capacity and capability building processes to increased technological innovation. The increasing demand and external competitiveness encourage economies to agree on free-trade agreements. However, the bigger economies in the region would like to strengthen their own trade blocks first and then negotiate, altogether, with larger economies. In recent years, China and India have become major players in the region, importing raw materials, industrial products and increasing energy investments. As for the industrial landscape, Latin America has launched programmes to renew and boost industrial parks. Most of these rely on public investments within the framework of promoting 'endogenous development' and improving the efficiency and effectiveness of production chains. Agro and IT (software) products are becoming a very important component of Latin American exports, with China being an important agro-consumer. Finally we should highlight the remarkable growth of the construction sector, both domestic housing and commercial/industrial building.

4. Regional integration

Latin American integration is no longer a utopia. Concrete and coherent actions show the regional commitment to the creation of a united voice for South America. The largest and most important trade block in the region is MERCOSUR integrated by Argentina, Brazil, Paraguay, Uruguay and (from mid-December 2005) Venezuela. These five economies have the largest population and GDP of the region. The second block is the Community of Andean Nations (CAN) which includes Bolivia, Colombia, Ecuador, Peru and Venezuela. In January 2005 MERCOSUR and CAN together with Chile have created an umbrella block called United Nations of South America (UNASUR). UNASUR is aimed to promote regional and international:

- market opening-up (100% free trade by 2010) with preferential tariff rates.
- cooperation and exchanges in culture, education and science.
- technological transfer.

5. Connection of Science and Technology to the economy

In general, the private sector has not invested significant amounts either in performing its own R&D or in placing contracts with public sector research institutions or universities. As a result technology generally comes from abroad in packaged form excluding even the possibility of adaptive R&D and there is too little (if non) productive research in the private sector. However, a considerable number of Latin-America's key leading industries are State-owned (Oil, mining, etc.) and within this very specific context there are state-of-art world leading technology development processes. To some extent local branches of multinational companies place contracts with research institutions and universities but these are not large in relation to overall budgets and are often one-off investments with limited repeat possibilities. Measures have been taken to increase the dynamism of innovation systems, including: support for the creation and development of innovative small and medium-sized firms, cooperatives and social production enterprises (EPS), use of incubators and technology parks, use of public procurement for innovation, and stimulation of the emergence of a venture capital sector.

6. Technological and economic opportunities

Priorities for science and technology and the opportunities presented by developments in key fields can themselves be seen as drivers for RTDI policy and for international cooperation. In the countries covered current research is dominated by the agricultural and energy sectors though other areas are well represented too. Policy priorities for future development include the promotion of:

- **Key areas** such as biotechnology, nanotechnology and ICT
- **Key sectors** such as:
  - Education (facilitating the move towards a knowledge society via basic education, literacy programmes, as well as research and application of ICT).
  - Health (promoting joint health programmes to fight against AIDS, tropical diseases, and infant mortality).
  - Energy (promoting regional initiatives such as PetroCaribe, PetroAndina, PetroSur & PetroAmerica).

- Agriculture (promoting agro-processes and food security with sustainable management of natural resources).
- Infrastructure (improving fluvial, territorial and aerial communication infrastructure, as well as water and sanitation services).
- Telecommunication (strengthening regional information networks such as TeleSur and TV Brasil).

7. Sustainability

This has emerged as a key priority for the RTDI efforts of nations and national science academies in Latin America, mainly due to the increasing interests of the public and the civil society. However, governments believe that the transition towards sustainable development should be aligned to national strategies on regional and endogenous development.

8. Education and human resources

Education is seen as the central challenge in developing a knowledge-based economy and society. National and regional strategies focus on the improvement of basic literacy and numeracy, youth take-up of S&T in schools, and investment in tertiary education. However, the improvement of 'functional literacy' (understood as the capability to effectively and efficiently use information society technologies) is seen as one of the most important emerging challenges. Brain drain is a factor but on the positive side the brain drain has created a diaspora which potentially can be networked to the benefit of the countries concerned. Within the RTDI sector there is also insufficient mobility between institutions and between public and private sectors.

9. Donor strategy

Latin American countries have little dependence on support from donors. National funding tends to be committed to salaries and basic institutional cost but not much for RTDI-related activities. More recently strong emphasis is made on demonstrating progress towards the UN Millennium Goals. Greater control and requirements from donors are expected to be required as well as more efficiency and accountability on the use of resources and greater organisation of activities.

10.International RTDI cooperation

The broader spectrum of scientific diplomacy has become more multifaceted as new actors such as China, Korea, India, and more recently, Arab and African countries engage in bilateral alliances with Latin American countries, usually with a product development focus. The role for intra-regional collaboration also needs to be articulated, especially on issues related to traditional knowledge, development of an integration culture, and undertaking a proactive and strategic attitude towards scientific cooperation (for example, designing a regional strategy for cooperation).

4.4.2 Possible futures

Three contrasting views of the future of RTDI in the region were articulated in the form of three baseline scenarios. Full versions of these scenarios can be found in the Supporting Documentation and on the project web site. Here, just the main ideas underpinning each of the scenarios are outlined.

Scenario 1 – Implementation gap
There are good RTDI policies drafted but not implemented and the region's visions are overshadowed by global pressures and limited regional integration. At the national level there are sub-critical education efforts which do not contribute to the achievement of a sufficient critical mass. Private sector engagement is too limited and not supported due to a lack of public resources to implement priorities and promote strategic sectors coherently and consistently. This uncertainty hampers entrepreneurship to some extent. In terms of sustainability there is no coordinated approach and international cooperation reinforces internal fragmentation.

Scenario 2 – On the casino wheel
RTDI remains detached from national and regional needs and efforts lack both public and private credibility and support, thus making RTDI investments inefficiently managed. As a result, the private sector does not risk its resources on local technological capabilities and the educational system suffers significant crisis. Sustainability is off the agenda and mono-productive models remain in place with little value-added processes. Integration becomes a taboo topic and RTDI international contributions shift towards more emergency and short-term assistance programmes.

Scenario 3 – we stand united
In Latin America new RTDI policies achieve public and private sector support and commitment for implementation. Reorganisation of national research systems around interdisciplinary problem-focussed centres of excellence allows a rapid shift to new technology platforms. In this context, RTDI investments target poverty reduction and other priority areas. At the regional level, joint research efforts contributes towards a multidimensional regional integration with strategic regional exploitation of the positive sides of globalisation. Building on attractive education strategies, the private sector understands the benefits of strengthening links with the national academic and governmental scientific community. Strong commitment to global regulations on sustainability and better RTDI links with the EU helps the region to progress on global targets, thus boosting cooperation and attracting donors.

4.4.3 2015 success scenario: towards a Latin American Research Area

A full version of the 2015 success scenario can be found in the Supporting Documentation. Here, a summary is provided:

> *In contrast to the situation in 2005, there are signs of multidimensional integration where, besides efforts for improving trade and commerce in the region, there is a strong governmental commitment to integrate the RTDI capabilities and research communities into a Latin American Research Area (LARA), a contextualised regional version of ERA (European Research Area). However LARA is more a result of an enlargement process (similar to that of the European Union) where South American countries played a key role in the creation of the South American Research Area (SARA).*

Reformed political institutions and more stable economic conditions have created conditions where policy-makers and the public have understood the positive impact of investments in RTDI activity on poverty reduction and other targeted priority areas. These – together with more fair and healthier relations with the IMF, other international / financial organisations and donor agencies – have lead to a major unlocking of resources for RTDI and a change in resource allocation patterns towards RTDI capacity-building. However, it is expected that the region's S&T expenditure will be at levels around 1% of GDP. Some countries though manage to expend more than 1% (e.g. Brazil).

Reorganisation of national research systems around interdisciplinary problem-focussed centres of excellence allows a rapid shift to new technology platforms. In ICT the surge in investment pays off as a cohort of qualified people begin to attract online business from outside the country. Biotechnology moves more slowly initially as a full policy infrastructure is put in place, for example to protect intellectual property and farmers' rights, but then catches up fast.

A concerted effort to promote technical education – particularly in the tertiary sector – produces a new cohort of scientists, technologists and technocratic managers who evoke a generational change in the public and private sectors and form the basis of a new entrepreneurial culture. They migrate to the more easily acquired leading technology areas and are able to market their services online. In time foreign firms are attracted by this new labour pool. The region also manages to promote policies which reward and connect researchers who live abroad and remain somehow attached to national interests (e.g. creating research networks, exploiting global opportunities and strengthening cooperation).

Cooperation begins with joint working on the desired attributes of the national innovation system. The national or regional strategy forms a natural focus for coordination between donors. The region's ability to show commitment and progress towards the UN Millennium Goals increases substantially the amount of resources given by donors.

A new alignment of foreign policy and scientific cooperation places the development of knowledge societies at the core of strategies for developing prosperous societies ready to take their place a valued trading and cultural partners of the European Union. The EU establishes strong and formal RTDI cooperation agreements with the leading Latin American block(s). But for all of this to happen, reform could not be confined to the countries in the region. The EU also had to take action in the form of (1) greater joined-up thinking and coordination between the various DGs of the Commission within the framework of "knowledge diplomacy" and (2) greater understanding of the benefits of an integrated Latin America.

4.4.4 Actions for consideration

In light of the vision set out in the success scenario, a number of challenges for the coming decade are highlighted here. Practical steps for addressing these challenges are also suggested, although these are initial ideas only and further discussion will be required in order to delineate a comprehensive action plan. Moreover, they address only those actions concerning international RTDI cooperation – there are of course many other actions that could and should be undertaken by national governments in the region independent of an RTDI cooperation agenda.

Challenge 1: Changing European mindsets and perspectives on the potential of the Latin American region

This can take a few years to achieve but could perhaps be accelerated if properly carried out. The critical issue here is to involve the right stakeholders, that is, key EC policy-makers (from most Directorates), recognised European and Latin American (EU-LA) researchers, respected EU-LA intellectuals, as well as key policy-makers from regional organisations in LA. An open space for conscious awareness and scenario workshops on the potential of Latin America after the consolidation of the South American Union (the twelve South American countries) would certainly benefit the EC's future plans for cooperation with the region (e.g. in the energy sector, where South America has extensive reserves of oil and gas; and in the financial sector, the South 3 Group - Argentina, Brazil and Venezuela - are proposing the creation of the Bank of the South). China has already changed its mindset and perspectives and is becoming more active with new cooperation and trade strategies towards the region. There are of course already some EC cooperation activities in this area, but in order to become a strong ally of the future regional block, the EU would need to be more proactive now.

Challenge 2: Promoting a 'Latin Agenda' by means of a coherent and supportive "knowledge diplomacy" necessary for mainstreaming social development, research and innovation at the regional level

The EC should disseminate some of the pros and cons of having set the Lisbon Agenda and encourage the region to prepare its own RTDI *'Latin Agenda'*. Mutually beneficial cooperation and partnership can only be achieved if there is a united and coherent supportive message from the European Commission towards the current sub-region's unification efforts. The EC should play a stronger role in encouraging European governments and research communities to explore opportunities and positive scenarios in the emerging South American block. A number of actions are required for this to come about, many internal to the workings of the Commission, but also some that are external, for example, information about opportunities of economic, social and political developments in South America as a block should be widely disseminated within the EC. Clearly, INCO alone will be unable to enact internal EC mainstreaming actions, but will need to co-opt several allies in other DGs and the Member States in an effort to push through the necessary reforms. But the idea itself, whilst ambitious and certainly for the medium to longer term, should be jointly explored and developed further by several European agencies, and rigorous efforts made to promote it.

Challenge 3: Encouraging and supporting institutional reform and consolidating research capabilities
Many Latin American countries have recently undertaken comprehensive and wide-ranging institutional reforms. From rewriting the constitution of the country (Venezuela) to restructuring the whole institutional research landscape (Colombia) to reorienting the country's research priorities (Argentina, Colombia, and Venezuela, among others). It is clear that much of the burden for implementing these reforms should rest with the national governments. However, cooperation actions with the EC could include the support of conferences on this subject area, training, exchange visits, and demonstrators of 'best practice' or case examples of institutional reform in other countries and regions. The EC should also assess its current cooperation policies and support actions in terms of the contributions they make towards enacting institutional reform and research prioritisation. Where possible and feasible, such cooperation support should be enhanced with a view to promoting implementation of the necessary institutional reforms.

Challenge 4: Making more reachable EU opportunities and increasing participation rates by the region's scientists
Few people in the EC delegations of the region have a comprehensive understanding of the FP and are therefore unsuited to promoting it. This has resulted in disappointing participation rates in FP6 by scientists from the region. One suggestion to emerge from the project was for the EC to assign "knowledge attachés" to its delegations, who would support activities such as awareness raising, partnership brokerage, proposal writing, and so on.

Challenge 5: Supporting emerging sub-regional integration initiatives
The South America sub-region is moving fast towards an integration process similar to that of the European Union. MERCOSUR and CAN have formed a larger South American block (Community of South American Nations or UNASUR). This integration is currently driven by energy and economic interests but in the future it is believed that deeper social and political integration could lead towards a unique and contextualised version of the EU. One suggestion to emerge from the project was for the EC to actively assist the sub-regional integration process via conferences, seminars and the establishments of High-Level Advisory Groups who will transfer EC knowledge and experiences to policy-makers and governmental officials in the region.

Challenge 6: Promoting mutually beneficial RTDI cooperation with each country and the international organisations active in the region
Already, there is some RTDI cooperation with MERCOSUR, CYTED, CAB, ECLAC, IDB and OAS. But greater coordination with other actors, including the EU Member States and other international organisations, such as the World Bank, is also necessary to maximise the value-added from Commission support. In the first instance, coordination could be limited to knowledge sharing on one another's activities in the region (e.g. standard RTDI indicators). A starting point for this might be the creation of a database that reports on the various programmes and initiatives being carried out. This could be augmented by annual meetings of the main agencies involved where future plans for new initiatives could be set out and presented. Joint evaluation of key policies that contribute to the successful achievement of the UN Millennium Goals in each

country is also recommended. This could certainly enrich future cooperation strategies for mutual learning, knowledge transfer and coordination of joint actions to reduce poverty.

Challenge 7: Promoting mutually beneficial cooperation between the EU and Latin America
Fairer and more open trade based on complementation rather than competition (similar to the UN Food for Oil programme) is being tested in the Caribbean region by the Venezuelan government, the so called ALBA initiative. The ALBA scheme has also been tested with Argentina in negotiations where cows, airport technologies and high-tech health equipment were exchanged with heating oil, diesel and gas. These so-called 'complementation-based trade schemes' could be also interesting for the EU25 (especially at a moment when oil and petrol prices are at historic high levels). One suggestion to emerge from the project was for the EC to promote a study for the identification of mutually-beneficial complementary trade sectors and technologies between European and Latin American countries.

Challenge 8: Achieving greater coordination of horizontal EC programmes in Latin America
The EU is already supporting Latin America via several horizontal programmes such as AL-INVEST (cooperation between European and Latin American companies), URB-AL (local urban development), ALFA (cooperation between higher education institutions), @LIS (alliance for information society), Alßan, (scholarships), and ALURE (cooperation in the energy sector). Some of the support measures suggested by participating Latin American countries (Argentina, Chile, Colombia and Venezuela) include the promotion of mechanisms improving the coordination of these horizontal EC programmes.

4.4.5 Main S&T areas

The main generic areas where the region has an interest in scientific cooperation include the following:

- ***Thematic research priorities***
  - Food security, Agro, Fishing & Biotechnology
  - ICT
  - Health
  - Energy, Oil, Gas & Nuclear technology
  - Environment & Natural resources/products
  - Nanotechnology & Material Sciences
  - Transport
  - Clean technologies and fine chemistry
  - Space technology

- ***Socio-economic research priorities***
  - Regional integration
  - Social inclusion (reducing poverty & digital divide)
  - Social innovation
  - Economy & sociology of technological change
  - Work and employment
  - Entrepreneurship

5. Overall findings and recommendations

5.1 Introduction

In this concluding chapter, the project's overall findings are summarised and recommendations for further action outlined. The project's findings are briefly summarised in terms of the common problems faced across all four regions before turning to some of the specificities found in each. Taking into account the previous analysis, ten generic themes for follow-up action are identified. In addition, responsibilities for follow-up action are also assigned to the EC, the SCOPE 2015 Project Team, and the National Correspondents.

5.2 Different regions, common problems

An initial concern of the project team was that the four regions under study are all very different and that this would make bringing them together in a single project of this modest scale problematic. Whilst there are a number of regional specificities that must be considered (see Section 5.3 below), it has been rather surprising to discover the scale of commonality:

- All regions suffer from chronic under-investment in RTDI. Whilst it is difficult to assign an appropriate target for research funding in developing countries, the levels of spending in many areas have actually fallen over the last two decades, leading to the deterioration of infrastructures and the loss of human resources. Funding regimes are rarely transparent and prefer, for the most part, to distribute resources through institutional block grants rather than competitive calls for research proposals.
- The so-called brain drain is of serious concern in all regions covered in the project. Whilst new thinking on mobility talks of brain circulation, the simple fact is that many countries covered by the project have few opportunities available for returning researchers. Mobility is therefore almost entirely in one direction towards the West and to the detriment of the regions, at least for the time being.
- To varying degrees, in many countries, RTDI institutions and governance are weakly developed and/or in need of reform. Institutional regimes tend to be modelled along traditional lines that see the academy (whether in the form of universities or other academic institutions) separated from the worlds of policy and business. This separation acts as a barrier to linking RTDI to real world socio-economic problems. It means that national systems of innovation fail to function in most countries across the four regions.
- At the same time, the private sector is disinclined to conduct its own research. Moreover, most indigenous firms show little interest in engaging with the science base and instead prefer to source their technology off-the-shelf from abroad. The linkage of science to innovation therefore remains weak.

- For most countries in the four regions, capacities tend to be minimal or are non-existent in new technologies such as nanotechnology. This raises the prospect of an ever-widening technological divide between the countries in these regions and the OECD countries.
- Common problems and challenges, particularly around the natural environment and the sustainable and efficient use of resources, loom large across all regions. Yet, the full potential of RTDI to contribute to the solving of these problems is rarely realised.
- There is an enthusiasm across the four regions for further collaboration with scientists in the EU, but a general lack of awareness of available opportunities, coupled with the bewildering complexity of the Framework Programme, have made cooperation difficult. The EC is well aware of many of the problems here, but the message from the scientists in the regions is that more needs to be done in FP7 to address them.
- To a varying degree, there is in all regions considerable interest in increasing RTDI linkages between countries in the region. This is most pronounced in SSA and LA, where models similar to the European Research Area have been proposed.

Given this commonality, it is possible to make wide-ranging recommendations for the improvement of RTDI framing conditions, such as those outlined in Section 5.4.

5.3 Regional specificities

As well as the areas of commonality, there are of course also important differences that distinguish the regions from one another (not to mention significant differences between countries in the same region). For example:

- CIS: This is partially a European space that falls within the remit of the EC's Neighbourhood Policy, giving it special strategic importance. It has a highly educated population with a rich and relatively varied scientific tradition. Its Soviet history and the shadow this still casts are distinctive, leaving behind a set of unique institutional arrangements and a legacy of practices that sometimes have difficulty in fitting with arrangements and practices elsewhere. Also uniquely among the regions covered, the physical and engineering sciences, along with mathematics and computer sciences, are the dominant areas of research.
- SSA: This region contains many of the world's poorest countries with pressing needs that call upon limited resources, leaving little room for RTDI activities. Political instability is rife and the apparatus of states are often underdeveloped. There is a heavy reliance upon aid from donors, which can create a situation where donors are more active in setting the RTDI agenda than the countries themselves. Reflecting developmental concerns, research in agriculture and medicine are the dominant areas of activity.
- MEDA: As with the CIS, this region also falls within the remit of the EU's Neighbourhood Policy. Although it is more culturally distinct from Europe

than much of the CIS, it is perhaps further along the road to some form of integration with the EU through the proposed Euro-Mediterranean Free Trade Zone, which is due to come into full force in 2010. The economies in this region are undergoing rapid changes, partly as a result of privatisation programmes, but also because of a recent influx of FDI, some of which is technologically-rich. Political systems remain rather opaque, however, and are marked by extensive clientelism and secrecy. Research fields are dominated by the need to manage the harsh climate (and the opportunities this might also offer), as well as resource extraction concerns.

- LA: The region has a long history of trying to wean itself off dependencies on the West, with economic policy from the 1950s to the 1980s dominated by import substitution and the building up of national champions. Such policies were believed to require self-sufficiency in research and technology, which lead to the establishment of much of the RTDI infrastructure present in the region today. Whilst the austerity of the 1980s and 1990s has seen much of this infrastructure eroded, the research areas being pursued remain wide-ranging, although a lot of activity is associated with agriculture, medicine, and the extractive industries.

It is of course important for EU RTDI cooperation policy to be sensitive and adaptive to these specificities, as a one-size-fits-all approach is unlikely to be successful. The recommendations made in the next section should therefore be considered with this point in mind.

5.4 Generic themes for discussion and possible action

In this section of the report, ten generic themes are highlighted for further discussion and action, drawing upon the various regional analyses summarised in Section 4.

1. Transferring and expanding the ERA concept: nurturing regional research areas and their cooperation with Europe

The idea of setting up regional research areas, similar to the ERA, has been suggested as a way to pool resources and better coordinate sub-critical activities at the national level in some of the regions examined here, e.g. Latin America. The EU should examine ways to support the development of such areas, drawing upon its own considerable experience in building the ERA. The EU should also review ways in which the ERA itself can be expanded to more effectively include researchers working in third countries. Consideration could be given to the introduction of an RTDI Cohesion Plan (modelled on experiences in EU) to address regional disparities and to assist weaker regions.

2. Building further coordination between DGs and between the Commission and Member States

Although there is already some coordination on RTDI issues within the Commission, there remains considerable room for improvement. In particular, DG Research needs to strengthen its links with other DGs if it is to provide

support for things like capacity-building, development of infrastructures, support for innovation, etc. in third countries. In addition, improved coordination and synergy between the cooperation policies and programmes of the EU Commission and Member States needs further attention, possibly through the extension of the ERA-NETs that are being set up to address this issue.

3. Operating with a mix of scales and instruments

One idea that has been highlighted in several regions is the support for triangular partnerships between different regions, e.g. Africa and the MEDA region, with Europe playing the third partner. This idea should be closely examined, since many regions face common problems that could be addressed collectively. On the other hand, the tendency to fund larger projects (as in the FP) is not always an optimal one to engage researchers in third countries. The Commission should therefore examine ways to improve its capacity to support local research projects and priorities and not just global networks. Essentially, a mixed approach (or "balanced portfolio") is required, which should be sensitive to differences and variations between countries in the same region and between different areas of research, but which also capitalises on the synergies and commonalities across regions.

4. Mainstreaming knowledge policies

Efforts at the better mainstreaming of knowledge policies are required at a variety of interfaces. For example, within the Commission, explicit knowledge policies need to be built into the vast majority of policy areas. But just as significant is the need to raise awareness in other international institutions and national governments of the importance of science and engineering investments to address basic needs and its vitality in all policy areas (for example, it is important to have a reference to S&T in the Poverty Reduction Strategy Papers). These things will not happen without strong advocacy from a coalition of actors, including DG RTD, and efforts should be focused upon enhancing the credibility and effectiveness of such lobbying efforts.

5. Investing in centres of excellence

The success scenarios in all regions make reference to the building of centres of excellence. In many countries, re-organisation of national research systems around interdisciplinary problem-focused centres of excellence should be a priority. Whilst the onus for doing this rests largely with national governments in third countries, the EU can help to support the development of centres of excellence through facilitating participation in Networks of Excellence and other FP7 instruments. It can also fund expert advisors to governments and other national actors who are interested in establishing such centres, as well as establish networks for exchange of good practice on this issue.

6. Supporting entrepreneurship and start-ups

The means for providing support for start-ups, young entrepreneurs and entrepreneurial universities should be examined, although within the framework of a coherent national/regional innovation strategy that is relevant to socio-economic needs. This will require a coordinated approach from different DGs of the Commission, reflecting the range of actors and activities that will need to be targeted.

7. Managing mobility for the benefit of all

There should be a far greater effort placed on supporting the mobility of researchers, for example, through fellowships and exchange visits, in order to build better international networks and to foster knowledge-exchange. However, this will need to be carefully managed to ensure brain "circulation" rather than brain drains from the developing world. In fact, without many of the other needed reforms highlighted in this report, brain drains will be inevitable, highlighting the interdependency of a multitude of system factors.

8. Enhancing information infrastructures at home and abroad

There is an unmet need for a wider overseas network of agents championing the FP and other EU support mechanisms, and acting as information points for guidance and support. The setting up of an FP National Contact Point-type system in all third countries and the appointment of knowledge attachés in a selected number is therefore recommended. The mechanics of how this might work in practice needs to be closely considered and Member States' overseas missions also enrolled. Simultaneously, there is a need to create a culture for international cooperation with third countries in the EU25, especially among Commission services and among EU scientific teams, in order to encourage and facilitate the inclusion of more partners from third countries. Stronger incentives need to be put in place together with a more supportive climate, whilst potential partners from third countries need to be more visible and accessible to EU research consortia.

9. Building capacity and infrastructures for RTDI policy making

A key weakness in most of the regions concerns a lack of skills for policy management and design in governments, not to mention a lack of understanding of the potential role RTDI has for national development. Support for skills development in RTDI and awareness-raising of its potential contribution to development should therefore be a high priority for the Commission. But lack of skills is only part of the problem: there is also the need to put in place better surveillance and monitoring arrangements that will generate the information necessary for better policy interventions. Besides the need for improvements in indicators and statistics, a strong message to emerge from the project was a desire to extend current EU information gathering projects, such as Trend Chart, R&D Scoreboard, and ERA-Watch, to other parts of the world. Trend Chart is already being rolled out in parts of the MEDA region, but this could be further extended to other regions. The Commission should therefore conduct a feasibility study in the first instance to assess the costs and benefits of following such a course of action.

10. Conducting further foresight exercises

During the course of the SCOPE 2015 project, several participants have suggested areas and themes where foresight exercises would be useful to carry out. These have included national exercises, regional exercises, technology area or sectoral exercises, and more extensive exercises focused upon RTDI cooperation. Various parts of the Commission should therefore consider the greater use of instruments like foresight for analysing and deliberating on issues of importance and for building leading visions that can guide future actions.

5.5 Responsibilities for follow-up action

SCOPE 2015 is a relatively small project in terms of its budget and duration, costing around €100,000 over 11 months. Consequently, the coverage of the project, its level of analysis, and the degree of participation achieved are all rather modest. Despite this, the project has generated a lot of interest, not to mention enthusiasm, and there are expectations as to possible follow through actions. With this in mind, some immediate actions are suggested in this section.

The EC might consider the following course of action during 2006:

1. The scenarios and other outputs from the project should be disseminated widely by DG RTD, as project sponsors, to the various Commission services;
2. A meeting could be convened between INCO, RELEX, DEV, EuropeAid, INTAS, etc. to discuss the project's results and implications. Some of these bodies already meet regularly in existing forums, and it is possible that the project's results could be discussed in one of these;
3. In light of this dissemination activity and discussions, feasibility studies might be set up and some of the recommendations and/or visions and ideas incorporated into policy documents;
4. The scenarios and action plans – after a further round of discussions and debate – could be published as visually attractive reports for wide distribution; and
5. The Commission should strongly consider funding follow-up foresight studies that are regionally specific and more extensive (both in terms of scope and depth). Indeed, the fact that this rather modest project has attracted so much interest should be taken as a signal for further similar work to be conducted in the near future.

As for the **SCOPE project team**, this is committed to the following actions:

1. Presentation and discussion of the project's findings if and when called upon (by the Commission or by others);
2. Preparation of briefings for INCO or others in the Commission (e.g. DG RELEX) based upon the results of the project. The results have already been incorporated into a high-level briefing of the INCO Unit's Director and his staff by two authors of this report on the future direction of the EC's international cooperation strategy;
3. Dissemination of the project's findings as widely as possible using international networks (national, inter-governmental and non-governmental); and
4. Publication of at least two academic articles in well-respected journals.

Finally, the **National Correspondents** and other national champions (for example, those who took part in the national forums) will also be asked to disseminate the various project reports as widely as possible in their own countries and regional networks.

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The SCOPE 2015 Project Team would like to extend their warm thanks to the following contributors to the project:

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Annex 2: Template for national correspondents' country reports

1. Introduction

2. Historical policy and institutional developments

- Briefly describe historically recent policy and institutional developments and reforms (we suggest going no further back than the last 20-30 years for this). The emphasis should be upon contextualising historical legacies that continue to have a strong influence upon contemporary thinking, policy and institutional organisation.

3. Contemporary institutional landscape

- Provide a brief description of the major research funders (e.g. Ministries), research performers (e.g. Universities, Academies of Science, etc.), research trainers (e.g. Universities, Technical Colleges), and research users (e.g. Legislators, Industry, etc.)
- How do these institutions relate to one another? And how have these relations changed over time? If there have been major changes, briefly explain their rationale.
- Perhaps include an organogram here, if readily available.

4. Role of donors and international organisations

- How important are donors in terms of a) research funding b) influencing research strategy and priorities?
- What kind of inputs do they make?
- What are the short and long term effects of their activities?

5. National RTD policy

- Who makes national Research and Technological Development (RTD) policy?
- What is current RTD policy? Here, we are thinking about highlights from strategy documents and legislation. Have there been any major RTD policy shifts recently? If so, what was the rationale?
- Are there any explicit (or implicit) RTD policy priorities?
- What are the major RTD policy drivers, both from within and outside the country? This might include a wide range of things, such as national economic profile (e.g. a dominant industry or company), international trade relations, IMF austerity programmes, civil service cultures, brain drains, political instability and corruption, etc. We suggest you just focus on the most important ones.

6. Future visions/Foresight

- Has there been a national Visioning or Foresight exercise? With what aims/timeframe?
- What role did this assign to RTD?
- Has it had any impact?

7. RTD funding: sources, levels and allocation mechanisms

- How much is annual RTD spending (absolute figures and as % of GDP)? What are the trends in spending patterns?
- Where does RTD funding come from? For example, how much comes from the public and private sectors? How much comes from overseas?
- At which scientific domains / economic sectors is the money directed? Have there been any recent changes in this regard? What about institutions – for example, are there any particular types of or leading institutions that receive the majority of the money?
- How are financial resources allocated to research performers? For example, through block grant? Through competitive funding? Through international aid? Again, any recent changes here?

8. Human and infrastructural resources

- How many researchers are active per 1000 people in the population? And what sorts of qualifications do they have?
- What is the state of development of research training? And what sorts of career path are open to scientists in the country? Any recent changes here?
- What is the current state of research infrastructures in the country, especially laboratory facilities and access to libraries / computers? Has this improved or gotten worse over the last decade?
- Researcher mobility – are there internal / external brain drains / gains? If so, what positive and negative impacts are these having?

9. Ability to address emerging RTDI priority areas

- To what extent is RTD seen as critical to future national development by political and economic elites?
- What, if any, research domain areas are believed to be the most critical over the coming decade for socio-economic development?
- Who holds this view and why?
- How well is the country's innovation system positioned to conduct RTD in these critical areas and to then go on and exploit the results? Are there any major mismatches or gaps? If so, to what extent will international cooperation be needed to address these?

10. International RTD cooperation

- What sorts of international cooperation already exists (a) with neighbouring countries, (b) with the EU, and (c) with other international agencies and foreign governments / organisations from outside of the region?
- What is your assessment of the benefits and limitations of this cooperation to the development of RTD in the country?

11. Prospects for advancing RTD in [Your Country]

- What is the potential for advancing RTD in the country over the coming decade?
- What, in your view, are the enablers and the barriers for future positive developments?

Annex 3: List of supporting documentation

Region	Report Title	Author
	RTD in Azerbaijan	sh Azakov
	RTD in Georgia	Zurab Chekurashvili
	RTD in Kazakhstan	Kamila Magzieva
	RTD in Ukraine	Igor Yegorov
	Key Drivers and Outlooks for RTD in the CIS Region	Michael Keenan
	Baseline Scenario 1: Islands of Excellence	Michael Keenan
	Baseline Scenario 2: An Expense We Can't Afford	Michael Keenan
	Baseline Scenario 3: A Science Renaissance	Michael Keenan
	CIS Success Scenario: Cooperation	Michael Keenan
Sub-Saharan Africa	a	Sunday Ojo
	RTD in Ghana	
	RTD in Kenya	Joe Malo
	ia	Ephraim Okon
	Regional Synthesis Report	and Luke Georghiou
	Baseline Scenario 1: Implementation	Jennifer Harper and
	Baseline Scenario 2: Cast into the Wilderness	Jennifer Harper and Luke Georghiou
	Connected	rper and Luke Georghiou
	Success Scenario: Innovation at the Heart of Development	Jennifer Harper and Luke Georghiou
Maghreb and Mashreq		
	RTD in Morocco (En) RTD in Morocco (Fr)	Said Belcadi
		abdallah
	Regional Synthesis Report	Patrick Crehan

	Baseline Scenario 1: The Gazelle Gets Lucky but maybe a Little Fat	
	Baseline Scenario 2: The Gazelle Runs Forever from the Lions	Patrick Crehan
	Gazelle: the Lions Better Watch Out!	
	Success Scenario: Knowledge Creating	Patrick Crehan
Latin America	RTD in Argentina (Es)	
	RTD in Chile (En) RTD in Chile (Es)	
	RTD in Colombia (En)	Javier Medina
	ezuela (En) RTD in Venezuela (Es)	
	Regional Synthesis Report	
	Baseline Scenario 1: Implementation Gap	Rafael Popper
	Baseline Scenario 2: On the Casino Wheel	Rafael Popper
	Baseline Scenario 3: We Stand United	Rafael Popper
	Success Scenario: Innovation and Development	Rafael Popper

Annex 4: A note on the relevance of nanotechnology and biotechnology for developing economies

Nanotechnology[3] is not an esoteric domain of interest only to the most developed economies. It is an emerging enabling technology that has a wide range of application across many domains. It is of relevance to traditional industrial sectors, as well as new and emerging industries. It provides new approaches to the hard problems of development laid out in the Millennium Development Goals.

The following table is based on a foresight exercise designed to clarify the role of nanotechnologies for developing economies as well as the possibility that they can contribute to the achievement of the UN Millennium Development Goals (MDGs).

Top-Ten Nano-Technology Applications for Development			**Contribution to MDGs**			
Rank	**Score**	**Domain**	**IV+V**	**VII**	**VI**	**I**
1	766	Energy storage production and conversion		✖		
2	706	Agricultural productivity enhancement	✖	✖		✖
3	682	Water treatment and remediation	✖	✖		✖
4	606	Disease diagnosis and screening	✖		✖	
5	558	Drug delivery system	✖		✖	
6	472	Food processing and storage	✖			✖
7	410	Air pollution and remediation	✖	✖		
8	366	Construction		✖		
9	321	Health monitoring	✖		✖	
10	258	Vector and pest detection and control	✖		✖	

Source: 'Nano-Technology and the Developing World' by Peter Singer et al available on the Public Library of Science – Policy Forum, Volume 2 Issue 4 e97 of April 2005. The full report is available at www.plosmedicine or directly from Peter Singer at peter.singer@utoronto.ca.

The Millennium Development Goals singled out for the contribution that nano-technology could make to address these goals are:

[3] Nano-technology is the study design, creation, synthesis, manipulation and application of functional materials, devices and systems through control of matter at the nano-scale (that is at the atomic and molecular scale), and the exploitation of novel phenomena and properties of matter at that scale.

Millennium Development Goals[4]

I	Eradicate Extreme poverty and hunger
IV+V	Reduce child mortality and Improve maternal health
VI	Combat HIV/AIDS, malaria and other diseases
VII	Ensure environmental sustainability

Nano-porous zeolites can be used for efficient storage and slow release of water and fertilizer for plants and of nutrients and drugs for animals. Nano-capsules can be applied to the controlled delivery of herbicides. Nano-sensors can be applied to the monitoring of soil quality and plant health. Nano-magnets can be applied to the removal of contamination from the soil. These are some examples of how nanotechnologies could be applied to enhance the productivity of **agricultural activity**.

In the case of **water treatment and remediation**, nano-membrane technologies can be applied to the purification, desalination and detoxification or water. Nano-sensor technologies can be applied to the monitoring of the **environment** and the detection of contaminants. Health care issues can be addressed for example with the use of nano-sensors for monitoring **health** and for the diagnosis of specific conditions. Nano-particle can be used to enhance the quality of medical images. Nano-capsules can be used for the controlled release of medicines and nutrients into the body. These issues are further developed in the cited publications of Peter Singer and his colleagues.

A similar foresight exercise was carried out by Singer to clarify the significance of biotechnologies for developing economies[5]. Whereas most research into genomic and other biotechnologies were concerned with the needs of industrialized nations, many of the potential applications are of considerable interest to developing nations as well. Singers foresight including a ranking exercise that lead to the following list of the top ten Biotechnologies for improving health in developing countries.

1. Modified molecular technologies for simple diagnosis of infectious diseases.
2. Recombinant technologies for vaccines against infectious diseases.
3. Technologies for efficient drug and vaccine delivery systems.
4. Environmental technologies for sanitation, water purification and bio-remediation.
5. Sequencing pathogen genomes to understand their biology and identify new antimicrobials.
6. Female controlled protection against sexually transmitted disease, both with and without contraceptive effect.
7. Bio-informatics to identify drug targets and to examine pathogen-host interactions.
8. Genetically modified crops with increased nutrients to counter specific deficiencies.

[4] A set of eight development objectives espoused by the UN with more information available at www.un.org/millenniumgoals

[5] 'Top ten biotechnologies' in Nature Genetics, Volume 3, October 2002, Pages 229-232.

9. Recombinant technologies for more affordable therapeutic products such as insulin and interferon.
10. Combinatorial chemistry for dug discovery.

Almost all panellists agreed on the importance of the top 3 technologies, though there was some variation in opinion on the ranking of the others.

Many infections are caused by the unsanitary use of injections and 80% of the cost of a vaccine is due to the cost of refrigeration. Powdered vaccines, edible vaccines and controlled release formulations that replace the need for multiple doses can address these issues. Recombinant vaccines have been successful where traditional vaccines have failed. Simple hand-held test devices that rely on the binding specificity of monoclonal antibodies or recombinant reagents to diagnose infection may be easily adaptable to settings without running water, refrigeration or electricity. Modified molecular technologies for the simple affordable diagnosis of infectious disease are important for prompt treatment, to limit the spread of the disease and to lower the cost of ineffective treatments. Biotechnologies or a combination of biotechnology and nano-technology can lead to the development of small, robust, light weight easy to use medical test-kits for treatment or diagnosis.

The sequencing of the genome of the malaria parasite *plasmodium falciparum* lead to a discovery that the drug *fosmidomycn*, normally used to treat urinary infection blocks an enzyme contained in the parasites genome revealing that this drug may provide the basis for a whole new treatment for the disease. The fact that the drug is already in use means that a lot is already known about the effects on such a treatment on the human body, shortening the time needed to complete clinical trials and obtain approval for its use in humans. Furthermore non-communicable diseases related to diet and nutrition can be addressed using genetic engineering of crop local staple foods. Bio-remediation is often less costly than other means of waste disposal and bio-informatics can be very cost effective due to the existence of large internationally available data-bases.

Cooperation on issues such as these would make a considerable contribution to achieving MDG VIII – A Global partnership for development.

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