The CARE Cycle:
A Framework for Analyzing Science, Technology and Inequalities

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In order to shape science and technology policies in ways that spread benefits widely, it is important to understand the contribution of science and technology to the creation and maintenance of inequality within and between societies. Inequality is the unequal distribution of something people value, such as income, health, or power. In its dynamic meaning, the word distribution refers to the processes of producing and re-producing inequalities. This article is concerned with the roles that science and technology play in distributive and re-distributive processes in contemporary society and how policy can intervene to generate less unequal outcomes.

A small but growing body of literature is analyzing the relationships among science, technology, and innovation (STI) policies and the dynamics of inequality in contemporary societies. Sarewitz (1997) calls attention to growing inequalities in the United States as a threat to the status quo of science. Wyatt (2000) and Senker (2001) gather sets of essays that point to connections among power, technology, poverty, and oppression. For example, Arocena and Senker (2001) analyze the connections to inequalities between nations and Sutz (2001) traces the consequences of international domination to the neglect of pressing problems within developing countries. Woodhouse and Sarewitz (2007) speculate on the kinds of STI policies that could help to reduce inequalities, in the context of a collection that presents a variety of suggestions on breaking the link that many see between inequalities and technology-led economic development.

As part of this effort, Cozzens and her colleagues (for example in Cozzens 1996, 2000, 2007, and forthcoming) have been developing the analytical tools to help formulate the policy problems systematically. In particular, they have stressed the different dynamics connecting inequalities to the various subfields of STI policy, research, innovation, human resource, and regulatory (Cozzens, Bobb, Bortagaray 2002); articulated three complementary place-based innovation strategies (Cozzens et al. 2005); and delved into the ways that one inequality, gender, intersects with others in the STI policy realm (Cozzens 2008). In a working paper, Cozzens and colleagues (2007) articulate a "social cohesion" policy paradigm for STI that addresses vertical and horizontal inequalities through pro-poor, egalitarian, and fairness policies.

This article seeks to further this emerging research agenda by providing an additional conceptual framework. The framework is called "the CARE cycle," because it highlights the interactions among capacities, accountability, representation, and effects (terms we will define and explain in the next section of the article). The CARE cycle provides a way of thinking about the relationships among three types of inequalities: structural, representational, and distributional. These can be briefly characterized as inequalities in individual and institutional capacities, in voice or power, and in sharing benefits and costs.

In comparison with earlier approaches, the CARE cycle concepts call attention to the analysis of dynamics among common policy options. The early work in the field has shown in principle that taking just one step at a time in reducing inequalities through STI policies is not enough; too many complex and possibly contradictory dynamics are set off by any single change. As an alternative, we propose to develop policies in the context of a cycle of reinforcing changes that together have the potential for significant redirection.

Section I of this article presents the framework itself, along with some of the research questions it generates. These questions are drawn largely from the problem-formulation phase of a research project called ResIST, "Researching Inequality through Science and Technology." [1] ResIST is seeking both to expand understanding of the dynamics of science, technology, and inequality and to translate that understanding into options for policies designed to produce less unequal, more inclusive results.

A major activity in the project's first phase has been to ground the research in policy practice by engaging with policy stakeholders around their problems and issues. Sections II and III of the article apply the concepts of the CARE framework to empirical materials gathered in this first phase of ResIST. Section II uses the CARE cycle to shed light on priorities in a diverse set of national S&T policies, through examples drawn from countries where ResIST is doing case studies. Section III uses the CARE cycle to raise issues with regard to specific examples stakeholders provided in the project's initial round of world regional meetings.

Our basic points are these:

1. The three types of inequality (Section I) form conditions for each other. High levels of inequality in one contribute to high levels in another; and conversely, decreasing inequality in one can help to decrease inequality in the others.
2. Attempts to reduce the three inequalities appear in the national science policies of many countries (Section II). While the profile varies across countries, each country has room for significant steps forward by combining the three areas.
3. Applications of the concepts in illustrative stakeholder case studies (Section III) reveal complex tradeoffs and no easy solutions. Yet the CARE cycle highlights particular aspects of these cases and points to suggestions and proposals for improved policies that reflect greater sensitivity to trade-offs and potential pitfalls.

[1] Many members of the ResIST team contributed to the problem formulation reflected here. For a full listing of project members, please see the project web site, http://www.resist-research.net/home.aspx..

I. THREE INEQUALITIES

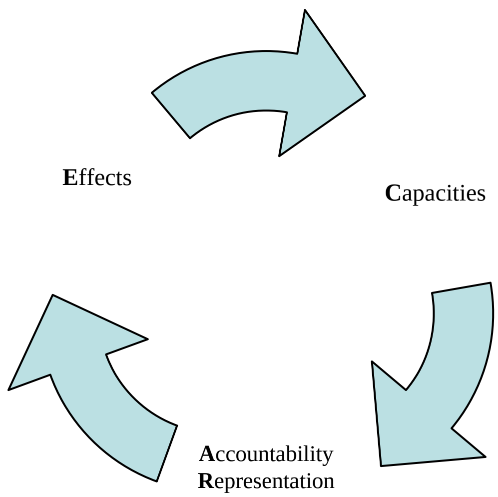
Inequality is a complex, multi-dimensional space, as Amartya Sen [year] elegantly describes in Inequality Re-examined. The three dimensions of inequality that we bring together in the CARE cycle[2] are by no means the only important ones with regard to science and technology. They do represent, however, three types of inequality that receive significant attention in STI policies and programs -- but usually separately, not together.

We use the term structural inequalities to refer to unequal distribution of human and institutional capacities. For example, the wide differences among European countries in the number of scientists and engineers per capita represent a structural inequality, as do differences in the number of women and men who enter science and engineering careers. The uneven spread of excellent research institutions across EU member states also illustrates this type of inequality. STI policies that focus on human resources and institutions frequently have the goal of reducing structural inequalities, as in U.S. programs to strengthen research competitiveness among the states or the encouragement in European Commission research projects to include women investigators.

Representational inequalities refer to differences in the permeability of decision making processes to inputs and influence from various groups. For example, decision making around health research in the United States is highly permeable to views not only from scientists but also from organized disease advocacy groups. In contrast, defense research decisions are highly impermeable to the most citizen groups while quite open to input and influence from defense contracting firms. A central concept in research policy, peer review, institutionalizes the role of one outside group, researchers, in decisions around project funding, while excluding non-researchers from those decisions. Yet a variety of other institutions are designed to create at least some decision power for other groups, like the members of the public on institutional review boards and biosafety committees.

The phrase distributional inequality refers to unequal distributions of the benefits and costs of scientific or technological change. For example, those with health insurance are more likely to benefit from new drugs and therapies than those without; the affluent are less likely to live close to major sources of pollution; subsistence farmers are less likely to benefit from new seed strains if they are expensive; etc. The benefits and costs of public science, technology, and innovation programs are referred to as outcomes or results, as well effects as we do here. Planning for and monitoring the achievement of outcomes has become a major part of the public management framework of many governments, and is therefore increasingly important in STI policies and programs.

[2] An earlier version of this framework was called CAPE, for capacity, alignment, participation, and effects. It was originally developed by Susan Cozzens, Peter Healey, and Johann Mouton.



Although the three types of inequality are usually viewed separately, we propose to treat them as three moments in a cycle of change. Together, they form the cycle of CARE, a wheel that can spin for the better or the worse. Inequalities in capacity contribute to inequalities in representation, which in turn perpetuate inequalities in the distribution of benefits and costs. Conversely, greater equality in capacity across groups and communities can contribute to more accountability in decision processes that lead to real improvements in basic needs for a broader range of communities. We illustrate these connections in the following subsections.

Distributional Inequalities (Effects)

We begin this discussion with inequalities in effects because reducing these is the objective of the overall effort, a goal shared between ResIST researchers and the project's stakeholders. We use the word effects in a human-centred and inclusive way, to refer to benefits and costs in everyday life for everyone, from the full population of a country to the full population of the world.

The phrase inequality in effects is one way of referring to problems that some people live with and others do not. ResIST stakeholders provided the project with many examples of inequalities in this sense that they wanted to reduce, including health and nutritional inequalities like malaria incidence and blindness from Vitamin A deficiency, environmental inequalities like living in proximity to industrial pollution or without provision for sewers; information inequalities like lack of access to the Internet; and the general pattern of deprivation called poverty. We explore some examples in Section III.

In STI policy, a standard approach to challenges like these is to try to solve the problem technologically. The attempt to develop a malaria vaccine is an example. But the technological approach addresses only one of the forms of inequality (effects narrowly conceived), and leaves inequalities in capacity, accountability, and participation in place. Technological solutions are less likely to be sustainable under these circumstances, and the solutions miss the opportunity for broader structural benefits. To tackle the problem, analysts need to take a broader view of the ways new technologies are embedded in different national contexts and thus explicate relationships between a variety of policies and the broad-based distributional effects of new technologies.

At the same time, S&T policy typically relegates the problem of unequal distribution of costs of such projects to other policy areas, such as regulatory policy. But the outcomes of those processes rest in turn on the capacities of the actors involved and on how accountability is organized – again reflecting conditions in other phases in the cycle of change.

Structural Inequalities (Capacities)

Many concepts that are used to think about science and technology incorporate terms from economics. Thus, the enterprise is seen to involve several types of capital (including physical, intellectual, human, and social) and several types of flows (including funds, knowledge, research materials, and people). The concept of structural inequalities refers to unequal capital assets, but a full analysis of the role of these inequalities needs to focus on the processes (flows) that build up or diminish those assets.

Human capital, and more specifically scientists and engineers, is a focus of S&T policy in many countries. Several dimensions of inequality characterize the distribution of human capital. National-level data on number of scientists and engineers, either in absolute or per capita terms, show great inequalities between countries and groups of countries.[3] Within countries, scientists and engineers and the institutions they work in tend to be concentrated in capital cities or a few other urban areas, thus often creating urban/rural differences in capacity.

These differences between geographic regions grow on a substrate of other kinds of inequalities within geographic areas, often based on *effects* that are associated with socioeconomic, ethnic, gender, and educational inequalities. Human capital theory predicts the relationship. The process of building science and engineering human capital (that is, providing advanced education in these areas) builds on more general forms of human capital investment (that is, primary and secondary education). Thus groups that are disadvantaged at the lower levels will probably be at least if not more disadvantaged at higher levels, through a process of cumulative (dis)advantage. For example, children from families carrying the health burdens of polluted

[3] See Technology Achievement Index, http://hdr.undp.org/reports/global/2001/en/pdf/techindex.pdf, accessed April 22, 2007.

environments are less likely to do well at school, and thus less likely to move forward into higher education or science and engineering careers.

The process of geographic cumulative advantage also characterizes the flows of people in the system. Places with fewer resources provide less attractive environments for scientists and engineers than those with more resources. So there is generally a flow from rural to urban within countries, and from less affluent to more affluent countries. Thus “effects,” the preceding CARE cycle moment, conditions the capacities of various communities to participate in and engage with STI.

This situation sets up a tension that STI policy research can explore. National governments invest heavily in human capital by subsidizing education at all levels, including fellowship programs for scientists and engineers to be trained abroad. But once the investment is made, an individual embodies it and can in principle carry it elsewhere. What is the proper balance between the state’s interest in investing in human capital for development at home and the individual’s freedom to go where the market and conditions are best for him or her? How can governments in the economically and technologically advanced regions of the world balance the import of highly skilled labour from low income countries with the responsibility to help developing knowledge infrastructures in poor and less developed regions? Both policymakers and researchers are interested in the answers to these questions.

More and more countries are addressing the loss of scientists and engineers through migration with increased efforts to recruit into science and engineering careers domestically. These efforts are often specifically targeted to groups within the country that are currently under-represented in science and engineering careers, usually women and historically disadvantaged ethnic or religious groups. Thus one cycle of cumulative advantage and disadvantage intersects with the other.

Representational Inequalities

There are a variety of processes that translate knowledge capacities into effects. S&T-intensive policy areas are characterized by dependence on technical expertise, which is often given deference over other forms of knowledge. This unequal dynamic then contributes to other processes, for example, setting the research agenda and taking regulatory action. Knowledge and technologies themselves then come to embody unequal relations. For benefits to be distributed widely and costs to be shared equally, S&T-intensive decision making processes must be broadly and effectively participatory and create real accountability to all groups in society.

Drawing on concepts in science and technology studies,[4] an inclusive framework for S&T policies would respect many forms of knowledge, from professional expertise through situated traditional knowledge. The STI policy literature tends to view traditional situated knowledge as a source of intellectual capital. For example, as we discuss in Section III, the CSIR in South Africa is developing a new product and local industry from indigenous knowledge.[5] But such situated knowledge is often also the key to solving particular problems in particular places and thus plays a more general role in achieving re-distributional effects. Expert and situated knowledge play different roles in accountability and participation processes, and an inclusive S&T policy must remain alert to these differences.

Accountability

Accountability is a pervasive feature of everyday life and social interaction. Institutionalized forms of accountability as they are found in politics, the economy, science, the legal field and in civic society are rooted in and build upon mundane everyday processes in which people hold themselves and others accountable for what they do and how they do it. At the institutional level accountability systems "provide for the explicit stating and framing of distributional issues related to the design, development, and social appropriation of scientific and technological resources" (Neyland, Nunes et al. 2007). Yet accountability systems normally make some things and processes visible but other aspects invisible. "The introduction of supposedly better forms of accountability like "performance indicators" may also produce "perverse" effects in which the lofty goals to be achieved are replaced by a focus on producing the right statistics."

Accountability systems attuned to the needs of the disadvantaged are a prerequisite for reorienting scientific governance towards greater social inclusion in building S&T priorities and in distributing its products. They are the means by which the potential distributional consequences of science and policy and practices can be recognised and assessed – and potentially incorporated – by formal elements of the political system. As global interdependencies become stronger and local and national forms of government or "governance" become intertwined with trans-national governance, systems of accountability also change. Locally situated forms of accountability become linked to and mingled with trans-national accountability systems. The boundary between alternative accountability systems and those of conventional policy and

[4] Science and technology studies emerged as a distinct field of academic and policy research in the 1970s. It combines deep philosophical and sociological analyses of the role of various forms of knowledge and technology in social life with policy oriented studies on how to harness various forms of knowledge and specifically science and modern technology to enhance economic performance, innovation and sustainable and inclusive social change. For an overview see
Jasanoff, S., T. Pinch, et al. (1995). Handbook of Science and Technology Studies. Thousand Oaks, CA, Sage.

[5] Vinesh Maharaj, "Bioprospecting Research: A Case Study," http://www.resist-research.net/cms/site/docs/Vinesh_Maharaj.pdf, accessed April 14, 2007.

practice is therefore an important site for the analysis of scientific governance, and one in which any reconfiguring of interests will take place (Neyland, Nunes et al. 2007).

It would be naïve to assume that existing and newly proposed forms of accountability in S&T policy are unambiguously geared towards the needs of the poor and towards addressing the various forms of inequality. Accountability systems embody a whole range of normative assumptions about the purposes and uses of S&T. The research base for a more inclusive S&T policy needs to explore such systems and how one may improve them and integrate them into more inclusive forms of representation.

Representation

Global accountability systems in areas like vaccines and e-wastes face the challenge of accountability at a distance: production, consumption, and disposal of the technologies escape accountability in part because they are distributed in different geographic locations. As already indicated, other accountability processes and especially formal political ones continue to operate in one place, through governments at local, regional, or national levels. These political systems traditionally tend to hear the voices of the rich more clearly than the voices of the poor and the views of technical experts more clearly than knowledge situated in communities. The issue of effective representation for everyone in government priority-setting processes is thus an important item for the research agenda under discussion.

In the practice of public administration, new systems are being designed in capacity building and priority setting that aim to remediate inequalities. These include experiments with participatory budgeting and knowledge-based policy-making. These new processes draw on conceptions of accountability that diverge from the typical focus on the relation between those who govern and those who are governed (Neyland, Nunes et al. 2007). Likewise, movement for social or environmental justice create forms of accountability.

In all these instances, new processes are being designed to counteract the elitist tendencies of political systems, including health councils and participatory budgeting, a process that gives real control to user communities over certain aspects of resource allocation. The policy research agenda on science, technology, and inequality needs to draw lessons from these experiments for the development of more inclusive, accountable and sustainable S&T policies in other settings and circumstances and explore how these processes more generally affect the various forms of inequality and the CARE cycle presented above.

II. POLICY CONTEXTS

The central challenge for this research agenda is to use concepts like these to develop tools that would allow policymakers to assess the distributional effects of their knowledge-intensive programs, either prospectively or retrospectively. Their decision environments are complex. They need to take into account external factors, relevant actors, rationales for action, and the instruments available.

This section draws on a review of national policy documents from several ResIST participant countries and on presentations at the three world regional meetings ResIST convened. These countries serve as examples of the various strata of the world economic system and different levels of S&T capability. As shown below. Mozambique is a low income country; Turkey and South Africa are upper middle income countries and Brazil falls just below the cut-off for this group. The UK and Portugal are both high income countries. This preliminary survey of their policies shows that a wide variety of approaches are currently being taken.

	UK	Portugal	Turkey	Brazil	South Africa	Mozam-bique
Population[6]	60.2m	10.6m	72.6m	186.4m	45.2m	19.8m
GNI/capita[7]	$37,600	$16,170	$4,710	$3,460	$4,960	$310
Technological Achievement[8]	.606	.419	Not available	.311	.340	.066
Gini index of inequality[9]	35.0	37.1	40.03	59.25	57.7	39.61

<u>Pro-growth emphasis</u>

In all the countries we examined, policymakers want to apply science and technology to produce economic growth. This goal is in general their highest priority. So for example in the UK, [10] the "Science and Innovation Ten-year Investment Framework" presented in 2004 is primarily concerned with the impacts of science on economic performance and international competitiveness. With the emphasis on keywords such as <u>excellence</u>, <u>dynamic research base</u>, <u>collaboration</u>, <u>confidence</u>, the explicit concern is on the impact

[6] World Bank, World Development Indicators, data for 2005
[7] Gross National Income per capita, World Bank, World Development Indicators, data for 2005.
[8] United Nations, Human Development Report 2001.
[9] World Bank, PovCal, accessed April 14, 2007; and WIID2 for UK and Portugal. Most recent years vary.
[10] Information on the UK in this section is based on the analysis of HMT (2006), *Science & Innovation Investment Framework 2004-2014: Next Steps*. London: HM Treasury (http://www.hm-treasury.gov.uk/media/D2E/4B/bud06_science_332v1.pdf)

of the system on innovation. Likewise in Portugal, [11] the "Technological Plan" aggregates a variety of measures expected to promote economic growth and social cohesion, based on knowledge, technology and innovation, focusing mostly on the exploitation of S&T for competitiveness. This plan is primarily concerned with contributing for economic growth and is hailed as the central piece in the national growth strategy.

The presentations at the ResIST world regional meetings also all stressed the centrality of science and technology to long-term growth strategies. For example, in Brazil, the Science Advisor to the Brazilian Senate presented a sophisticated analysis of Brazil's current situation and the need to move from use of technology to innovation.[12] In Turkey, a leading industrialist described this transformation in a major manufacturing firm.[13] The Minister for Science and Technology in Mozambique included contributing to economic growth among the goals of his office, as did the presentation on South Africa's S&T strategy.[14]

In other work, we identify the limitations of focusing entirely on economic growth in S&T policy are well known and articulates the need for a broader view of the benefits of S&T for human development (Cozzens, Kallerud et al.). In our survey of S&T policies, however, attention to the other benefits appears to be inversely related to the wealth of the country formulating the policy. Brazil, for example, stands at the polar opposite of the above mentioned European countries in its internalization of issues of inclusion in S&T policy.[15] The Strategic Plan for S&T in Brazil identifies as a horizontal axis of action strengthening the national system of research and innovation and identifies three additional vertical axes. These include one on promoting innovation following the Industrial, Technological and Foreign Trade Policy, one on developing strategic programs central to the country's sovereignty and one explicitly dedicated to "Science, Technology and Innovation for Social Development and Inclusion."

While the concerns with the economic impact of S&T are naturally central, this strategy does not leave to market and social forces the work of externalizing the impacts on inequality, but rather internalizes these

[11] Information on Portugal in this section is based on the analysis of PT (2005), *Plano Tecnológico: Uma estratégia de crescimento com base no Conhecimento, Tecnologia e Inovação. Documento de apresentação*. Lisboa: Conselho Consultivo do Plano Tecnológico do XVII Governo Constitucional Português (http://www.planotecnologico.pt/Docs_PT_DS/OPlanoTecnologico.pdf)

[12] Eduardo Viotti, "S&T Policy and Development: Reflections from a Brazilian Perspective," http://www.resist-research.net/cms/site/docs/resistwrm_programme_ebv.pdf, accessed April 22, 2007

[13] Iffet Iyigün Meydanlı, "Management of R&D in Turkish Industrial Companies: the Case of Arçelik," http://www.resist-research.net/cms/site/docs/Arcelik_R&D_2007_March8_short1.pdf, accessed April 22, 2007.

[14] Michael Kahn, "Science and Technology Policy in South Africa," http://www.resist-research.net/cms/site/docs/Micheal_Khan.pdf, accessed April 22, 2007.

[15] Information on Brazil in this section is based primarily on the analysis of MCT (2004), "*Plano estratégico do Ministério da Ciência e Tecnologia 2005-2007*". Brasília: Ministério da Ciência e Tecnologia do Governo Federal Brasileiro (http://www.mct.gov.br)

objectives. In addition, this has been reflected at the organizational level of the system, with the implementation of a new Junior Ministry of Science and Technology for Social Inclusion (SECIS), created with the mission of promoting social inclusion through actions that improve the quality of life and stimulate the creation of jobs and income.

Similarly, the challenge for Mozambique's S&T policy is clearly intertwined with inequalities.[16] While it includes actions directed towards the strengthening of the existing research institutions, of the relationship of the research system with civil society and the productive sector, of the advanced education system, or of technological innovations, it also includes explicit actions directed to different forms of inequality. These include:

- promoting the expansion of research institutions throughout the territory;
- promoting the participation of women and youth in research;
- promoting research and the use of local knowledges;
- promoting the integration of local knowledges in the formal system of education;
- promoting innovation in the production and use of local knowledges;
- creating conditions for the diffusion in the media of local knowledges.

By emphasizing to the importance of local knowledges, the connection to distributional issues is made clear. The impacts of S&T can only be appropriated if they are not in competition with other knowledge systems, but rather part of the same ensemble of knowledges.

The South African research system underwent significant changes following the demise of the apartheid era.[17] While specific sectors, such as the nuclear and defense industries, were targeted, there were wider impacts in the research system. After an initial phase when innovation took central ground, recently five key technology missions were identified. These are information technology, biotechnology, manufacturing technology, technologies to add value to natural resources and technologies to impact upon poverty reduction. While these objectives are being highlighted in South Africa, other typical instruments of S&T policy are also being implemented, focused on scientific

[16] Information on Mozambique in this section is based on the analysis of Conselho de Ministros da República de Moçambique (2003), "Política de ciência e tecnologia e a sua estratégia de implementação." Resolução nº 23/2003 de 22 de Julho. *Boletim da República*, I Série – nº 31: 349-355; Conselho de Ministros (2006), *Plano de acção para a redução da pobreza absoluta 2006-2009. (PARPA II).* Maputo: Conselho de Ministros da República de Moçambique (https://www.govnet.gov.mz/docs_gov/programa/fo_parpa_2/PARPA_II_aprovado.pdf).

[17] Information on South Africa in this section is based largely on the analysis of DST (2006), *Corporate Strategy 2005/6-2008/9.* Pretoria: Department of Science and Technology of the Republic of South Africa (http://www.dst.gov.za/publications/reports/corp_strategy.pdf); DST (2004), *Indigenous Knowledge System*. Pretoria: Department of Science and Technology of the Republic of South Africa (http://www.dst.gov.za/publications/reports/IKS_Policy%20PDF.pdf)

excellence and economic impact. Nonetheless, the salience of the social impact initiatives, when compared to other countries is worth highlighting. It raises some difficult questions about the differences in semantics, rhetorics and realities of policies and policy documents as they occur in various contexts.

Structural inequalities

All the countries we examined also included programs for building science and technology capacity in their countries in their S&T portfolios. In the higher income countries, these instruments focused on recruiting individuals into science and engineering careers, but in the lower income countries, they also included institution-building activities.

In Portugal, "human resource policies and programs" are taken as particularly instrumental to the country in catching up with other nations. National policy calls for several activities in this area, and reflects the centrality of reducing structural inequalities by giving particular attention to the impact of these policies on the improvement of the education and advanced qualification levels, rather than on potential sectoral impacts, for example.

In the UK, possibly as a result of the strengthening of the devolution process, the main structural inequalities identified are at the regional level, and a greater role to address these "gaps" is recognized for the local development agencies. Other forms of inequality explicitly identified are concerned with "women and other low participatory groups." Rather than being directed explicitly to the potential distributional impact of these asymmetries, the concern is mostly with the functioning of the system, of guaranteeing participation (and in that sense, structural), rather than with the outcomes of such structure.

Turkey is working hard to develop its human resource base, through fellowships, exchange programs, and active participation in European integration.[18] Mozambique is building a higher education system almost from scratch,[19] and South Africa is struggling to transform a previously segregated system into one that serves the whole population. The few strong research universities of South Africa are undergoing transformation, while historically black colleges and universities are being merged with previously white institutions to stimulate learning and development. Although 80% of the population is black, the previous situation of structural inequality was so severe that today's achievement of about a quarter black staff members at

[18] Ahmet Ademoglu, "Recent Developments in R&D in Turkey: Strategy, Policy, Funding," ; http://www.resist-research.net/cms/site/docs/Resist_07_03_07_ahmet_ademoglu1.pdf, accessed April 22, 2007; Fatih Sahin, "Turkey 's Science and Technology Initiatives Towards South East Europe and the Western Balkans," http://www.resist-research.net/cms/site/docs/ResIST_SEE_WBC_Sahin.pdf, accessed April 22, 2007.

[19] Orlando A. Quilambo, "The importance of ResIST for the Eduardo Mondlane University," http://www.resist-research.net/cms/site/docs/Prop_Quilambo_Roland(a)[1].pdf, accessed April 22, 2007.

universities[20] is a huge step forward, and a fully representative science and engineering cohort is far in the future.

The most pointed discussion of scientific mobility at the World Regional Meetings took place in Rio, where a staff member from the Ibero-American indicators network presented a review of the deepening crisis in northward migration and the limited options available to countries of the South to stem the tide or reap benefits from it.[21] Brazilian colleagues pointed to the connection between their country's meager, but rapidly increasing, production of Ph.D.s (10,000 per year, but only about a third in science or engineering) and historical ethnic divisions, with both indigenous Brazilians and Brazilians of African descent left almost entirely out of the science and engineering labor force. Capacity-building there has to climb two steep cliffs of inequality, one internal and one external.

Representational inequalities

There are widespread references in both policy documents and stakeholder presentations to the need for processes of consultation in shaping S&T policies. In the U.K., representational inequality is an emerging concern. The lay public is treated increasingly at a par with scientists, with "public understanding" giving place to "public engagement," "participation,"and "public confidence." Nevertheless, the locus of this concern is somehow tilted towards the protection of those already traditionally represented ("improve the promotion of science in society," "improve public confidence in the Government's use of science"), rather than otherwise (e.g., improving the participation of society in science, or providing new mechanisms of accountability on the Government's use of science).

The ambiguities of this position are illustrated by the Committee on Radioactive Waste Management (CORWM),[22] which has a responsibility under legislation to recommend disposal options to the government. Its terms of reference require it to ensure that the review of options is carried out in an "open, transparent and inclusive manner…engag[ing] members of the UK public and provid[ing] them with the opportunities to express their views, [along with] other key stakeholder groups." CORWM itself has also embraced equity as a principle, "striv[ing] to avoid favouring particular groups, stakeholders, communities or regions" and using deliberative processes. With the exception of its long-term additional objective of trying to achieve intergenerational equity in its proposals, CORWM makes clear that its short-term aim is to make recommendations that are "both practicable and sustainable."

[20] Michael Kahn, "Science and Technology Policy in South Africa," http://www.resist-research.net/cms/site/docs/Micheal_Khan.pdf, accessed April 22, 2007.
[21] Lucas Luchilo, "Trends, policies and impacts of international mobility of the highly skilled on developing countries," http://www.resist-research.net/cms/site/docs/resistwrm_programme_ll.pdf, accessed April 22, 2007.
[22] www.corwm.org.uk, accessed April 17, 2007.

In Portugal, a general concern with inclusion in S&T policies is implemented through Public Understanding of Science programs. However, rather than focusing in these programs on issues of representational inequality, there is a focus on a deficit model of public understanding, i.e., public ignorance (a form of structural inequality) and, eventually, on the relevance of greater understanding of science for day-to-day activities (some distributional impact). In Turkey, the lead science agency acknowledges the need for participatory and accountable processes,[23] but provided few concrete examples.

The comprehensive Brazilian plan to use S&T for social development and inclusion incorporates some clearly participatory processes, such as “popular cooperative incubators.” Specific actions are also directed at specific under privileged groups of the population. For example, there is an action to promote social technologies for traditional communities, recognizing how these have historically been excluded from policies for economic and social improvement, thereby making clear the existence of representational inequalities being addressed.

The Brazilian attempt to link S&T to social inclusion also draws a variety of informal science education efforts into this portfolio. Thus the presentation from the Ministry on this area included efforts to bring the benefits of science museums to more of the country’s children through traveling exhibits, and other kinds of activities that fall in Europe under the rubric of “Science in Society.” These represent an interesting combination of outreach and capacity building, although the deficit model of science education is still in evidence in the examples given.

The first paragraphs of the “Science and Technology Policy” document from Mozambique illustrate well that S&T do not have a fully dominant position within knowledge systems as in some of the other countries analyzed here, clearly indicated by the low levels of access to S&T by the majority of the people and by the emerging stage of scientific culture of the country. The identification of science as one among other forms of knowledge in the national S&T policy is both recognition of a weaker S&T base in world terms as well as the recognition of the importance of other knowledge systems in local society. At the same time, this document makes clear that, at the global level, S&T has emerged not only as the dominant knowledge system, but also as central to an increasingly interlinked global economic system. The implicit acknowledgement of structural inequalities as well as of representational inequalities is therefore made clear. It is not only the fact that there are less S&T resources in the country, but also that other strong knowledge systems are weakly represented in the global system.

[23] Ahmet Ademoglu, “Recent Developments in R&D in Turkey: Strategy, Policy, Funding,” ; http://www.resist-research.net/cms/site/docs/Resist_07_03_07_ahmet_ademoglu1.pdf, accessed April 22, 2007.

In South Africa as well, there is a strong concern with local knowledges (here framed as "indigenous knowledges"). The development of an Indigenous Knowledge Systems (IKS) policy was led precisely by the Ministry of Science and Technology and adopted in November 2004. Besides the relevance of an inclusive approach to knowledge from the Ministry of Science and Technology, this policy is also particularly relevant as it links IKS directly with the S&T system. It does not limit itself to stating the need for the recognition of IKS. It includes a broad perspective on IKS in almost full parallel with general S&T policy concerns. For example it includes discussions of the IKS in the National System of Innovation of South Africa, a discussion of the role of research institutions within IKS, IPR issues, as well as an IKS information and research infrastructure. Furthermore, it clearly considers that "IKS development is a unique opportunity to recognise and redress inequities created by past policies in South Africa."

Distributional inequalities

The concern with distributional inequalities – uneven distribution of benefits and costs – is also inversely proportional to the wealth of the nations in this group. In Portugal, the S&T plan pays particular attention to issues of inclusion, in particular through *access* to the "Information Society". This can be considered a form of distributional inequality since the use of knowledge, which depends on access to it, is likely to have a positive impact on its users. ICTs are given particular importance through their appropriation not only by the economic dimension but also through social actors. Inclusiveness is also considered beyond the "information society". In particular through the improvement of education levels, portrayed not only in international comparative terms but also as a form of improving inclusion within society. In the UK, indirect concerns with impacts on inequality are clearer with regard to medical research, and its potential impact in the NHS, where "equality of access to high quality care for the entire population" is a major concern. Issues of distributional inequality appear to be mostly ascribed to the role of science and research across government, rather that to science and research itself. The primacy of the concerns with economic impact is also reflected here.

In the Brazilian inclusion plan, the areas of activity of this strategic objective include actions directly oriented towards addressing inequality (in general terms) through S&T, such as through actions on "social technologies," "assistive technologies," "popular cooperative incubators," or more traditional initiatives on "local productive arrangements," "technological vocational centres" or "digital inclusion." The concern with distributional impacts is also explicit on including as priorities within this objective "research on basic sanitation," as well as "research on health, food nutrition and food safety," or "S&T in the Northeast and Semi-Arid," reflecting some local primary concerns of the population, and not simply an international research agenda.

With regard to Mozambique, it is also relevant to note that S&T is included as one of the central horizontal issues relevant to the "Action Plan for the Reduction of Absolute Poverty 2006-2009" (PARPA II). This identification is alongside other elements with a significant technical component, such as HIV/AIDS, Environment or Food and Nutritional Safety, and the particular importance given to ICTs in this respect. The concern of the relationship between S&T and inequality is clear. It is not only driven from within the system, but it is drawn upon to address specific social outcomes.

Also in South Africa, distributional inequalities are of central concern within the national S&T policy. In particular, the strategic mission of impact upon poverty reduction has been identified as having "achieved some notable successes, particularly in the area of essential oil production, and new programmes in aquaculture show[ing] great promise" (DST, 2006: 2). Nevertheless, the application of "social technologies" has had some drawbacks, partly resulting from higher expectations. The objective of developing "technologies to reduce the cost of housing, to enable low cost communication [...] or practical sanitation" have not followed plans, and higher levels of funding are expected. And in other areas the concerns with different forms of inequality also emerge. For example, in international partnerships, and following years of political isolation, the focus on themes interesting both parties is considered key. Examples given include the European Developing Countries Clinical Trials Partnership, for drugs targeting locally endemic diseases such as malaria, tuberculosis and HIV and AIDS.

<u>Summary</u>

In sum, both our text analysis and the presentations at the ResIST world regional meetings confirm that the visibility of inequality as a theme in science and technology policies is higher in countries with lower national wealth, higher income inequality, and deeper poverty. This pattern is not surprising, but it does point to an important observation for the research agenda on science, technology, and inequalities. Inequality is not just one of the problems to be addressed, but also one of the barriers to be overcome in using science and technology for sustainable human development. It will be a major challenge for this research area to show how issues of inequality are at play even where they are not made explicit and presented as such. Equally difficult will be following policy design through to implementation and impact. Another major challenge will be to explore the basis of such inequalities and how they may be addressed more adequately through more encompassing conceptions of S&T policy and innovative forms of organizing inclusion, accountability and representation.

III. CASE STUDY CONTRASTS

As part of our stakeholder consultation, we asked participants in the world regional meetings to give their perspectives on a few examples of issues that ResIST results might illuminate. Their examples form a site for illustrating the three phases of change and for evaluating the applicability of the general policy approaches presented in Section II.

Toxic Waste

The environmental justice movement's reason for being is to call attention to and take action on the unequal distribution of costs – a distributional inequality problem. Our ResIST stakeholders meetings included only one presentation on the movement, in Rio, but we could have included local activists in other meetings, from Mozambique, South Africa, or Turkey.[24] In Rio, Juliana Malerba briefed us on the principles of the movement and its work in Brazil with regard to cultivation of soya, transport of wastes from São Paulo to Bahia (a richer state to a poorer one), and disposal of used European tires in Brazil.[25]

This movement addresses all the forms of inequality. Its goal is to reduce distributional inequalities, or as Malerba put it, "the unequal distribution of socio-environmental impacts."[26] Inequalities in capacity are inherent in the area: professional knowledge is generally at the service of polluters and regulatory agencies in these controversies. But the movement over the years has taken on the challenge of building its own knowledge base, and it is aided by public research institutions like Fiocruz.

Furthermore, the movement is participatory by definition, led by NGOs in the defense of communities. It lifts up situated knowledge and gives it voice in the political process. As Malerba put it,

> … at the origin of the actions promoted or carried out by the network is the understanding that whereas different social groups or communities will endow the environment with different uses and meanings – a river, for instance, has a very different meaning for indigenous communities and for companies which produce electricity – these will be disregarded when the time comes to decide on the implementation of a project, due to current power relations in society. … We believe that environmental conflicts and social struggles involving environmental issues can be very important for changes in the distribution of power in society, for they claim the recognition and valuing of different ways of living, or organizing, or producing and of relating [27]

The movement is aimed precisely at accountability: making patterns visible that affect the lives of disadvantaged ethnic and socioeconomic groups.

But in these materials we can see the enormous disconnect between official science and technology policy and the environmental justice movement. The policy review in Section II did not reveal any acknowledgement

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[24] For Southern Africa, see http://www.groundwork.org.za/, accessed April 17, 2007. With regard to Turkey, Environment & Society work is being done at Bogazici University, Istanbul – see Göksen, F. / Seippel, O. / O"Brien, M. / Zenginobuz, E.U. / Adaman, F. / Grolin, J. (eds): Integrating and Articulating Environments - A Challenge for Northern and Southern Europe. 2003.

[25] Juliana Malerba, "Environmental Justice Network," http://www.resist-research.net/cms/site/docs/resistwrm_programme_jm.pdf, accessed April 22, 2007.

[26] Malerba, op. cit., p. 2.

[27] Malerba, op. cit., p. 2.

of the role such movements might play. The electronic waste example in Section I raises issues that are in principle those of environmental justice, but are framed in terms of sustainability. The mechanisms of accountability are EU regulations and audits, not a social movement. Likewise, the voices of the movement have scarcely been incorporated into the environmental research agenda.[28] And in Africa, the discussions on science advice for regulatory issues are focusing on professional expertise, not community wisdom (Juma and Yee-Cheong 2005). Grass roots organizations both nationally and trans-nationally appear central to successful coalitions in order to promote accountability as social control of public policies by citizens.

Sweet Potatoes

Several presentations at the ResIST stakeholder meetings illustrated a front-line area for poverty reduction that has also been part of research policy for more than a century: agricultural research. In his presentation in Maputo, Calisto Bias described the participatory priority-setting process for agricultural research in Mozambique.[29] And in Rio, Roger Cortbaoui described the work of his international research center on potatoes, the fastest-growing food crop in the developing world.[30]

Bias's presentation illustrates the blending of pro-growth and pro-poor objectives. The priorities are a mix of subsistence crops, aimed at local food security, and cash crops intended for export. Reducing unemployment is an explicit objective, alongside improving the balance of payments. The national agricultural research institute must devote some attention to building capacity in the whole national system, while producing locally-useful research results. The research objective for the laboratory is the same whether the objective is food security or export crops: find a way to increase yields by 20%, so that projected poverty reduction targets can be met. Yet the capacity issue looms large: there are only 50 people working on these basic crops in the national agricultural research institution. The priority-setting exercise redistributed small numbers of them, and expressed hopes for the resources to hire more.

Cortbaoui's presentation intersects with the Mozambiquan story. His International Potato Research Center (CIP) has staff in Maputo, and they are working with Bias's staff on potato projects. Like many efforts in Mozambique, international collaboration is not a luxury but a basic staple. Cortbaoui's center makes capacity-building one of its missions, training dozens of developing country scientists in its main laboratory and helping many others with access to international-standard research. The system of international research centers that CIP is part of are committed to "farmer-embracing" rather than "industry-

[28] See the Partnerships for Communication at the National Institute of Environmental Health Sciences, http://www.niehs.nih.gov/translat/envjust/envjust.htm, accessed April 22, 2007.
[29] Calisto Bias, "Priority-Setting for Agricultural Research," http://www.resist-research.net/cms/site/docs/Calisto_Bias.pdf, accessed April 22, 2007.
[30] Roger Cortbaoui,, "Science and Technology for and by the Developing World," http://www.resist-research.net/cms/site/docs/resistwrm_programme_rc.pdf, April 22, 2007.

bound" agricultural research, including "free exchange of germ plasm, fair benefits sharing, recognition of traditional germplasm-related values and knowledge, wide access to genomics data bases, and empowerment of farmers to manage technology and access markets."[31] It thus addresses issues of representation and accountability along with capacity and distribution.

The core of Cortbaoui's story, however, is the battle between the beetle and the baby. The child needs Vitamin A to prevent vitamin-deficiency blindness, which takes sight away from a half million children a year. A new sweet potato strain provides enough Vitamin A to prevent the problem. But when the conventionally-bred version is grown, the beetle eats more than the baby – the infamous "post-harvest loss" to pests. It is the genetically-engineered version that would allow the child to eat more than the beetle. But genetically-engineered crops have not been cleared for planting in any East African country, including Mozambique. The country simply does not have the capacity to develop and enforce complicated bio-safety regulations, especially in a global trade environment with shifting reactions to genetically modified foods – a situation that lets the beetles continue to win over the babies.

How would Bias's participatory priority-setting process deal with this issue? Is the sweet potato high on the agendas of local farmers? When so many challenges are pressing, should Mozambique direct its scarce human resource capacity in biological research to developing bio-safety regulations?

Malaria

Malaria is one of the key health tragedies of the contemporary world. Although the disease is completely treatable with current technologies, millions die annually from malaria infection. Many of these are children, who are particularly vulnerable. Malaria clearly counts as a "health inequity" in the definition shared in a presentation in Rio: "health inequalities that in addition to being systematic and relevant are also avoidable, unjust, and unnecessary."[32]

In Mozambique, over 5 million cases of malaria are reported annually and about 3600 people die from the disease each year.[33] Controlling and eventually eliminating malaria infections and death is clearly on the policy agenda in Mozambique, as it is in much of the tropical world. Because so much is at stake in bringing malaria under control, there are dozens of high-profile international campaigns devoted to the same goal.[34]

[31] Cortbaoui, op. cit., slide 25.

[32] Alberto Pellegrini, "Research and Health Inequities," taken from Whitehead 1992. http://www.resist-research.net/cms/site/docs/resistwrm_programme_apf.pdf, accessed April 22, 2007.

[33] World Health Organization, Global Health Atlas, http://www.who.int/globalatlas/DataQuery/default.asp, accessed April 13, 2007.

[34] See a partial list at http://www.artemisininproject.org/Malaria/other_initiatives.htm. accessed April 20, 2007.

Clinical trials

These factors form the external context for work against malaria in Mozambique, and an easy justification for concentrating efforts in this area. Key national actors are the Ministry of Health and the National Institute of Health. One instrument of change that the Mozambican government is using with regard to malaria is the Centro de Investigação em Saúde da Manhiça (CISM, the Manhiça Health Research Center).

> Situated 80 km to the north of Maputo, Manhiça is a small rural town where the health research centre was established in 1996 as part of a joint collaborative programme between the Fundació Clinic (Hospital Clínic - University of Barcelona), the Ministry of Health and the Eduardo Mondlane Universtity School of Medicine. Financed by the Spanish Agency for International Co-operation, the CISM forms part of a bilateral co-operation programme established between Spain and Mozambique.[35]

In fact, CISM brings a number of international actors onto the scene in Mozambique. It receives funding from six public and seven private organizations outside Mozambique, including the European Union, several sources in Spain, UNICEF, the Bill and Melinda Gates Foundation, and GSK, a pharmaceutical firm.[36]

In the structural dimension of our framework, CISM represents a new institutional capacity for this part of the Mozambican countryside. It is the result of international collaboration, accompanied by mobility of health professionals between the Clinical Faculty of Barcelona, Eduardo Mondlane University in the capital city of Maputo, and rural Manhiça. The center embraces a three-pronged mission: research into the issues facing the district; "an intense training programme of Mozambican scientists, physicians and technical personnel in order to strengthen capacities within the country"; and providing health care to the surrounding community.[37]

A key to the high level of international interest is the fact that CISM has the capacity to run clinical trials on behalf of international firms. CISM was in fact in the news within the last year as the site of a successful clinical trial for a malaria vaccine under development by GSK (formerly Glaxo Smith Kline) in partnership with the Malaria Vaccine Initiative (MVI), a Gates-foundation funded program.[38]

Within the context of Mozambique, CISM is a model program, meeting basic needs by providing health care, building national capacity through international collaboration, and sharing that capacity with other regions through the training program. In terms of representation, CISM described their

[35] http://www.manhica.org/pages/ingles/ingles.htm, accessed April 13, 2007.
[36] http://www.manhica.org/pages/ingles/ingles.htm#, accessed April 13, 2007
[37] http://www.manhica.org/pages/ingles/ingles.htm#, accessed April 13, 2007
[38] http://www.malariavaccine.org/files/051511-Press_Release-Extended_Efficacy.htm, accessed April 22, 2007.

efforts to maintain good communication links with the local community, stressing the importance of having social scientists on staff to stay in touch with the ways that clinical trial procedures are perceived by the community. While there was no description of a community-based priority-setting process, perhaps the reported plea from participants -- “When is the vaccine coming?” – is a strong enough voice.

That plea, however, dramatizes the structure of the situation. The people of Manhiça are living with malaria, but GSK and MVI are in control of the anti-malaria solutions. Public-private partnerships of the GSK-MVI kind can create accountability to the partners, but not to developing countries (Neyland Nunes et al.). Perhaps the ultimate form of accountability of a clinical trial to the community participating in the trial would be to assure that when the vaccine is available, it will be available to them. There is no sign of such an assurance for Manhiça. MVI’s literature says that in general it supports making medicines available through advance purchase commitments, but no such commitment has been made for the malaria vaccine. Thus Manhiça may get the benefits of a temporary infusion of money to create an environment that is conducive to experimentation, but is not assured of the distributional effects they need so badly: actual access to the vaccine.

Traditional remedies

One pair of stories reported on a different angle on the malaria problem in the form of efforts to produce anti-malarial remedies based on local knowledge. Adelaide Agostinho described a project at the National Institute of Health to develop a tea made from the plant *Artemisia annua*. *Artemisia* is the source of a traditional treatment for the malaria parasite, used for centuries in China. Another Gates-sponsored international effort is applying high technology to the task of making the active ingredient available inexpensively for malaria treatment.[39]

Traditional medicine is being reborn in Africa, and new legal frameworks have encouraged its development, with international agencies, national agencies, associations of traditional healers, and researchers all playing roles. The research on *Artemisia annua* is just part of this effort in Mozambique. The advantages of treatments based on traditional medicine are considerable in the Mozambican context: “no dependence on highly qualified expertise, no dependence on imported medicine, no dependence on pharmacies (Green Pharmacies), no intellectual property rights related restraints on use, improvement and research.”[40] Artemisinin tea is in clinical trials at the Institute.

[39] http://www.artemisininproject.org/, accessed April 22, 2007.
[40] Adelaide Bela Agostinho, “Malaria and herbal therapies: where science and traditional knowledge meet,” slide 10, http://www.resist-research.net/cms/site/docs/Adelaide_Agostinho.pdf, accessed April 22, 2007.

South Africa is undertaking a similar effort in commercializing a traditional mosquito repellent.[41] But there are a number of contrasts between the stories. The lead organization in South Africa is the Council for Scientific and Industrial Research, CSIR, the largest research institution in Africa. CSIR is still mostly commercially oriented but has added poverty reduction to its missions.[42] The malaria-related project CSIR staff presented to ResIST researchers is part of CSIR's bio-prospecting work, an effort to draw on indigenous knowledge to commercialize valuable properties of South Africa's abundant biological diversity. Indigenous knowledge can bypass many steps in the classic, rational approach to drug discovery, and CSIR is trying to mine it for that purpose, focusing in particular on developing technologies to establish community-owned agro-processing businesses, with an emphasis on therapies relevant to South Africa, e.g., malaria, TB, and HIV remedies.[43]

The CSIR colleagues presented the case of BP1, a compound extracted from a local plant. An MOU was signed in 1999 and a benefit sharing agreement was signed in 2003 with the traditional healers who brought the plant to CSIR's attention. High technology then went to work. Scientific research identified the volatile components of the plant; gas chromatography determined the chemical profile of the essential oil; olfactometer tests showed "the efficacy of the samples to repel mosquitoes"; and bioassays and toxicology are underway. These steps led to a patent for a mosquito repellent, which in turn became the basis for community-owned businesses in four provinces. The effects appear to be modest but positive, with jobs at several skills levels created and the potential for growth.

The contrasts between the two stories illustrate the influence of capacity. CSIR capability brings sophisticated techniques to bear on traditional knowledge. Rather than orienting to reducing local costs, the project seeks export markets. In both cases, there is due deference to traditional knowledge, and the local ownership in the South African case provides accountability, representation, and jobs.

IV. POLICY OPTIONS

This survey of national policies and case studies has clearly not provided any recipes for how to turn concepts of inequality into policy options, but they have illustrated the interactions among the three forms of inequality we are illustrating in this article. While trying to improve effects, capacity can be built. But without accountability and representation, it is not clear whose interests will be served in the long run. Capacity contributes to the strength of

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[41] Vinesh Maharaj, "Bioprospecting Research: a case study," http://www.resist-research.net/cms/site/docs/Vinesh_Maharaj.pdf, April 22, 2007.

[42] David Walwyn, "The CSIR: A Few Introductory Comments," http://www.resist-research.net/cms/site/docs/Dave_Walwyn.pdf, accessed April 22, 2007.

[43] Vinesh Maharaj, "Bioprospecting Research: a case study," http://www.resist-research.net/cms/site/docs/Vinesh_Maharaj.pdf, accessed April 22, 2007.

accountability and representation processes, and only through them can it be aligned with the goal of reducing inequalities in effects.

However, the case studies also illustrate that the neat cycle of CARE turns out to need more arrows, in more directions. Poverty does limit capacity (for example, South Africa can not transform township dwellers into researchers overnight). But capacity can be used to address basic needs (an arrow turned backwards), for example, by developing better housing options to improve public health in the townships, thus giving its children a better chance to become researchers eventually). Processes of accountability and representation among township dwellers can create the public demand that directs capacity towards the most pressing needs of that community (another arrow running in the opposite direction from the original cycle).

What is clear from the dialogues ResIST has stimulated in national contexts is that any solutions developed using the three concepts will need to be tailored to particular national histories and circumstances. Mozambique's current crying need for capacity creates a different set of tradeoffs on accountability than those that would be made in Portugal, for example. Turkey's relationship to Europe puts the options being explored there front and center in the policy agenda, even when the circumstances are quite different. Brazil's popular government requires explicit labeling of social inclusion efforts, but its large population, modest capacity, and internal inequalities may make real progress on the agenda more difficult than in poorer countries.

STII research thus has very important questions to ask as it moves forward. For example, what are the re-distributional consequences of the growth strategies? What are the growth consequences of the re-distributional strategies? What options build capacity in both communities and S&T institutions? What options set genuine local priorities? Questions like these will certainly keep this research area busy over the coming years.

REFERENCES

Arocena, Rodrigo, and Peter Senker. (2001). "Technology, Inequality, and Underdevelopment: The Case of Latin America." Science, Technology & Human Values 28: 15-33.

Cozzens, Susan E. (1996) "Quality of Life Returns from Basic Research, in Technology, R&D, and the Economy, edited by Bruce L. R. Smith and Claude Barfield. Washington, DC: The Brookings Institution and the American Enterprise Institute, pp. 184-205, plus 208-209.

Cozzens, Susan E. (2000) "Dismantling Disadvantage: Women, Minorities, and EPSCoR States as American Egalitarian Projects" in Strategies for Competitiveness in Academic Research, edited by J. Scott Hauger and Albert H. Teich, AAAS.

Cozzens, Susan E. (2007) "Distributive Justice in Science and Technology Policies," Science and Public Policy 34(2), 85-94, March 2007.

Cozzens, Susan E. (2008) "Gender Issues in U.S. Science and Technology Policy: Equality of What?," Science and Engineering Ethics.

Cozzens, Susan E. (forthcoming). "Innovation and Inequality." In The Co-Evolution of Innovation Policy: Innovation Policy Dynamics, Systems, and Governance, edited by Stephan Kuhlmann, Philip Shapira, and Ruud Smits, Edward Elgar.

Cozzens, Susan E., E. Kallerud, et al. (2007). "Science, Technology, and Inequalities in the Global Knowledge Economy: Policy Dimensions." ResIST Working Papers. Oxford, UK, James Martin Institute, Oxford University

Cozzens, Susan E., Kamau Bobb, and Isabel Bortagaray. (2002). "Evaluating the Distributional Consequences of Science and Technology Policies and Programs," Research Evaluation, 11 (August): 101-107.

Cozzens, Susan E., Kamau Bobb, Kendall Deas, Sonia Gatchair, Albert George, and Gonzalo Ordóñez. (2005). "Distributional Effects of Science and Technology-Based Economic Development Strategies at State Level in the United States." Science and Public Policy, February.

Jasanoff, S., T. Pinch, et al. (1995). Handbook of Science and Technology Studies. Thousand Oaks, CA, Sage

Juma, C. and L. Yee-Cheong (2005). Innovation: applying knowledge in development. London, Earthscan

Neyland, D., J. A. Nunes, et al. (2007). Articulating New Accountability Systems; Towards an Integrated Framework Interim report. ResIST Working Papers. Oxford, UK, James Martin Institute, Oxford University

Sarewitz, D. (1997). "Social Change and Science Policy." Issues in Science and Technology Online.

Sen, Amartya. (1992). Inequality Re-examined. Cambridge, MA: Harvard University Press.

Senker, Peter. (2001). "Editorial," Science, Technology & Human Values 28: 5-14. Introduction to special issue on technology and inequality.

Sutz, Judith. (2001). "Inequality and University Research Agendas in Latin America." Science, Technology & Human Values 28: 52-68.

Wetmore, Jameson. (2007). "Introduction to special issue on science, policy and social inequity," Science and Public Policy 34(2): 83-84.

Woodhouse, Edward and Daniel Sarewitz. (2007). "Science policies for reducing social inequities," Science and Public Policy 34(2): 139-150.

Wyatt, S., F. Henwood, et al. (2000). Technology and In/Equality: Questioning the Information Society. London, Routledge.