Shifting positions for knowing and intervening in the cultural politics of the life sciences[1]

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This volume, with its contributors drawn from different disciplinary persuasions within science and technology studies (STS)[2] and from geography, ecology and developmental biology, has provided a range of interpretive angles on the metaphors, narratives, models, and practices of life sciences. Changing Life should help enlarge the community of participants in both cultural studies and STS and add to the emerging links between these two areas of scholarship.[3] In principle, both directions of exchange between cultural studies and STS are open to exploration. This collection, however, favors the assimilation of the study of science and technology (S&T) into cultural studies. In contrast, some practitioners within STS have argued that they have the tools needed to address culture in S&T, and have been doing so with a clarity and precision that should be more widely adopted.[4] I do not agree with this defensive STS reaction. Nevertheless, because my goal in this afterword is to stimulate further work on problems in both STS and cultural studies, I want to provide some balance to the assimilationist tack of the volume as a whole. Let me start, there fore, from some concerns of sociology of scientific knowledge (SSK), a well established branch of STS.

SSK shares with philosophy of science an epistemological concern with how scientists establish knowledge, yet it has sought to undermine philosophers' accounts by examining how scientists as actual, not idealized, agents make their science. Questions of epistemology and agency form my starting point here. These questions, however, become more complex than SSK tackles once we acknowledge, as Changing Life does, the large and heterogeneous arena in which life is re/constructed, an arena extending from genetically hybrid organisms to transnational economies. To better address such questions I identify five "shifts in positioning." Through the first shift scientists come to be treated as agents who construct jointly their knowing and intervening by mobilizing heterogeneous resources; the other four shifts build on this picture. The point, however, is not to refine our accounts of how scientists work in different contexts. Instead, I want to argue that, although the five shifts are already underway in particular sectors of cultural studies and STS, they can be pushed further and applied to a wider class of agents, ourselves included, who not only interpret, but also intervene in science,

technology, and culture.[5]

Science and technology as culture

Let me set a backdrop for discussing agency and positioning in both STS and cultural studies by first recapitulating the cultural-studies-assimilates-STS direction of linkage: Texts and other discourse about the meaning of science and technology are a significant, even dominant part of culture. With a cultural studies orientation one might choose some development in S&T--the more recent the better, given the field's emphasis on contemporary issues--and interpret the intertextualities in which that S&T is positioned. To a greater or lesser degree every essay in this volume provides interpretations in this spirit: Gilbert animates our thinking with his body politic metaphors; and Gottweis encourages us to see genetic engineering as a tool for production of identity. Schroeder and Haila identify destabilizing contradictions: Is ecology a resource for disciplining or for solidarity? Halfon traces discursive webs around population policy making; Taylor deconstructs global environmental discourse--and his own deconstruction. Edwards reveals a declining cultural anxiety about cyborgs; Cole points out the ironies in commercial preservation of the genetic lines. And Love deflates our overseriousness: Are we bubbles in a cosmic saucepan?

More generally, S&T is an exceptionally fertile substrate for cultural studies. The reasons are various: S&T has a history of simultaneously making universal, context-less claims and serving powerful institutions, such as the military. Cultural studies has gained much of its political purchase by demonstrating the situatedness of just such purportedly universalist or totalizing accounts and exposing the privilege such accounts afford to dominant processes and groups. "Deprivileging" requires upsetting the easy equation of Progress with Science and Technology as the producers of ever more detailed, refined accounts of nature and ever more effective interventions in nature. Cultural studies also works to develop counter-discourses by elevating cultural strands other than the powerful and publicly visible, exploring tensions among diverse groups and identities, and focusing on conflicts during changing eras. In this spirit, dominant representations of Science and Technology can be disturbed from many angles: We can map cultural intersections across strands or sites such as those of domestic life, schooling, workplace, popular culture, and nation. We can attend to class, gender, sexual, ethnic, and other cultural differences within and among those strands. We can examine histories of traditions--ascendant, dominant, residual, sub-altern, and oppositional--especially during transitions between eras--from colonial to post-colonial, or modern to post-modern. "Disturbing"

can be taken further by interpreting the mutual constitution of these strands, differences, and transitions; their rhetorical and pragmatic separation; and their ongoing reconfiguration.

In short, there is readily definable work to be done in a thoroughgoing, critical cultural studies of S&T--or, rather, S&Ts. With S&Ts assimilated into the more general category of cultures, cultural studies can provide a range of new directions of interpretation for STS.[6] Without at all intending to detract from this project, let me now consider one strand of the reverse exchange, exploring how aspects of SSK might be extended to suggest areas of future development for both STS and cultural studies.

Questions of scientific and cultural agency

Sociology of scientific knowledge as it developed in the United Kingdom in the 1970s shared with philosophy of science a concern with how scientists establish knowledge claims. By looking at what scientists actually do, especially when knowledge was disputed, SSK was able to displace the idealized and agent-less accounts of hypothesis testing and empirical refutation previously fashioned by philosophy of science. SSKers documented how observations and experimental demonstrations are susceptible to divergent interpretations and how this interpretive flexibility can be exploited rhetorically to maintain or dispell scientific controversy.[7] Sociology must, they argued, be brought in if the trajectories of actual and potential disputes, or, more generally, of scientific practice are to be explained.[8]

"Examine how scientists actually make their science." This directive for studying epistemology sociologically, when suitably broadened, provides a critical angle on agency in cultural studies and cultural politics. We need to clarify how agents of diverse kinds bring about the outcome under discussion, and examine how these and other agents do something with that discussion. Consider, for example, Donna Haraway's accounts of twentieth century life sciences. During the 1980s Haraway showed how certain episodes in various sciences involved the working out of concerns about social order and disorder. These concerns change as society changes, and this social change is, in part, conditioned by changes in the life sciences.[9] Haraway's work offered a way to extend Raymond Williams' reading of ideas of nature as reflections of ideologies of social order.[10] Not only in popular ideas about nature, but in the sciences of nature themselves, society has been naturalized, and nature socialized.[11]

Of course reciprocal proceses of naturalization and socialization occur in unevenly changing and partial ways that are sometimes contradictory.[12] Yet, where connections between science and social order are

observed, the question of agency of change remains: How did scientists and allied agents actually make their work in a way that we can later interpret as corresponding to concerns about social order? Discursive interpretations of science in terms of resonances, shared metaphors, and scripts often imply that social order become internalized in the subjectivity of agents, and from this seat becomes expressed in all that the agents do.[13] Agents are in this view primarily makers and maintainers of meaning and identity. Such interpretations might suffice if a historian provides, after decades have passed, a narrative overview of the scientific and social order. However, when we attempt to extend science-social order connections up to the present and hope to intervene into future-making,[14] we need more practical insight into the materiality of doing science and of doing science differently.[15]

Although SSK provided me a starting point, I do not propose that cultural studies of S&T should model itself on SSK in order to clarify what scientific agents do in constructing scientific, technological, and cultural order.[16] After all, SSK has had little to say about the theoretical challenges that arise when the boundaries of S&T are extended well beyond the laboratory, when scientific practice includes commodification, transnational networks, regulation by States and by capital, new social movements, and discourses of globalization, marginalization, individualization and hybridization--processes that are central to Changing Life.[17] Nevertheless, the epistemological bent of SSK might still be evident as I outline five moves that should help us better articulate and address, intellectually and practically, such theoretical challenges.[18]

1. From standing on foundations to heterogeneous construction

I am studying, simultaneously, colonialist practices, engendered practices, and generational practices. I am studying unstable ecologies which are simultaneously local, regional, national, transnational, and global. I am studying the production, reproduction, consumption, and revisioning of knowledge. I am studying a community's strategic practices (visual, verbal, mathematical, mechanistic, financial, computational, institutional, pedagogic, governmental, etc.) for doing physics. I am studying how all their strategies shape and are shaped by each other. Do physicists (and historians and anthropologists) have their own kind of common sense? Are there aesthetic pleasures about thinking? Do machines crafted by physicists make science? Do rhetorical devices make texts? Are simulations desirable? And I am most certainly a part of what I study. [Anthropologist Sharon Traweek describing the study of high energy physics

communities in Japan and the U.S.[19]]

Where do we position scientists as knowers and interveners? SSKers and other critical philosophers have made it impossible to imagine that scientists could stand on a firm foundation gained by accessing reality in some way independent of themselves as knowers. The fantasy of transcendent, disengaged knowledge must be replaced by recognition of necessarily partial perspectives. Those who follow the feminist standpoint theorists prefer the partial perspectives available to women from their daily life experiences,[20] or, more generally, perspectives from subjugated standpoints, "because they seem to promise more adequate, sustained, objective, transforming accounts of the world."[21]

We can displace scientists even further from the position of neutral objectivity claimed by or for them, if we redescribe their projects of representation as articulations of the "clusters of processes, subjects, objects, meanings, and commitments" that make up or situate "situated knowledges."[22] Similarly, when expressed in the terms of "actor-network" sociologists of S&T such as Law, Callon and Latour, scientists use a wide diversity of things in the process of making S&T; they mobilize equipment, experimental protocols, citations, the support of colleagues, the reputations of laboratories, metaphors, rhetorical devices, publicity, funding, and so on.[23]

The outcomes of scientists' work--theories, readings from instruments, collaborations, etc.--are accepted, in this view, because their networks of linked resources make the outcomes difficult to modify in practice. These scientific and technological outcomes become, in turn, resources for on-going scientific work.[24]

The greater the quantity and heterogeneity of things in clusters or networks, the harder it is to pin down what knowledges correspond to. No one kind of thing can be separated out--and this means deep, underlying reality as well--from the list. The speed of change exacerbates the problem (I will return to this later) as does the dimension of discursivity: Agents work with, among other things, images of what the world is like; faced with overlapping clusters or reticulating networks, agents discursively simplify or reduce the complexity. Moreover, they can to some extent vary the discursive reductions from context to context and employ them as additional resources in their ongoing network building. Ironing out these added twists into a single dimension of correspondence becomes at best a discursive reduction, not a plausible representational project.

Suppose we let go of questions of correspondence between knowledge and some reality, and shift our focus to the processes of agents building representations and other scientific products by combining a diversity of resources, that is, to the agents' heterogeneous construction.[25] No

longer are agents persons upon whom influences or factors impinge, which leads them to see, clearly or with distortion, the "nature of nature." Instead they are persons who have to mobilize diverse resources. No longer are their subjectivities some kind of internal representation of, and thus a surrogate agent for, the external social order. They mobilize resources imaginatively, projecting themselves into possible engagements with the world in order to assess, not necessarily explicitly, the practical constraints and facilitations of establishing a scientific outcome in advance of their acting.[26] Agents' concern with modifiability of outcomes means not only that when intervening in the world they draw upon representations, but also that they cannot help but implicate considerations of interven-ability in their very making of representations.[27]

Clusters and networks, discursive reductions and heterogeneous constructions, imaginative representing-intervening--can this complexity be disciplined?[28] If we shift our interpretive position so as to address the processes of heterogeneous construction, epistemological challenges are raised for STS: How do we discern which of the diverse components so mobilized make a difference and analyze how those resources are combined to do so?[29] While doing this we have to grapple with historically contingent situations resulting from multiple intersecting processes, in which boundaries and categories are problematic, levels and scales are not clearly separable,

and structures are subject to restructuring. Differentiation and change, not adaptation or equilibrium, characterize these situations of "unruly" complexity.[30] The interpreter has to consider simultaneously the practical implications of different constructions and the agents' discursive reductions of those constructions. Control and generalization are difficult and no privileged standpoint exists; the boundary between scientist and engaged interpreter can hardly be maintained.

If all this were not trouble enough, as interpreters we also have to build our own networks. We select and juxtapose components in narratives, fashion boundaries and categories, and employ conventions and technologies of representation in order to convince intended audiences, to secure ongoing support from colleagues, collaborators, and institutions, and to enlist others to act on our interpretations--or, more broadly, to stimulate them to build webs that reinforce our own interpreting. In short, interpreters are also heterogeneous constructors; all the preceding discussion of how to position scientists as knowers and interveners applies to ourselves. This invites us to reflect on the range of practical conditions that enable us to build and gain support for our own interpretations of scientific activity.[31] At the same time, in most intellectual discourse it still makes practical sense for scholars to avoid such practical reflexivity and discursively discount such additional complexity.[32]

More generally, when faced with all these layers of unruly complexity, the dominant intellectual strategies have reduced or suppressed them, narrowly circumscribing some system, structure, or underlying process and representing its evolution as subject to simpler determinations.[33] Such "system-izing" is in principle rejected by cultural studies, which emphasizes contingency, contextuality, unevenness, difference, and reflexivity. In its place cultural studies offers an image of a field of inquiry that always begins in "an in-between space where methods from existent disciplines... may be appropriated and refigured."[34] It "proceeds by way of a cutting-out and stitching-together of the various theories and theorists (and experiences and narratives) extracted or escaped from the various epistemological prisons... This weaving together utilizes differences without isolating or 'preserving' them."[35] The propositions or "heuristics" woven together are necessarily partial; the products are contributions to on-going weaving by others.

This alternative image of method mirrors the complexity of material and the diversity of participants in the wider arenas of sciences, technologies and cultures with which we are concerned. What it leaves unclear, however, is just how partial propositions can be woven together while interpreters remain in the "in-between space." As a consequence, simple determinations and correspondences remain an implicit resource in the metaphor-making and oppositional strategies of cultural studies. Let me amplify this criticism by describing further shifts that I associate with the shift to heterogeneous constructionism.

2. From mental and verbal images to "acting as if" as meta-metaphor

Among the resources drawn on by agents, whether they are working as scientists or cultural interpreters, is a sense of what the material and social world is like. Interpreters observing this "likening" try to convey what it is like, that is, they employ "meta-metaphors." Consider, for example, the range of terms that involve likening in Haraway's work: Agents are involved in: noninnocent conversations using visualization technologies; holding partial perspectives; situated knowing; story-telling; embodied vision; worldly diffraction; viewing the doings; materialized refiguration. Without worrying what each of these terms mean, notice that all but the last term connotes the making of mental and verbal images; images that we believe or think the world is like, or that we speak or write as if it were like. In general, whether one highlights the public and interactive dimension of representation as Haraway (and cultural studies) does, or its mentalistic and subjective connotations, likening is taken to mean having an image that corresponds to the world.

Yet there is another sense of likening, one that parallels the first shift

in our basis for knowing and intervening, namely, we also act as if. In fact, while viewing, speaking, writing and thinking are indeed actions, they are particular kinds; "acting as if" could be viewed as a more inclusive meta-metaphor of likening.[36] Proceeding in this way, when we examine what is at stake in any representational or discursive work, we would ask what it is that the agents are trying with their ideas to do something about and what needs to be done practically in order to modify their moves. Following this line of questioning, the activity of scientific and interpretive agents can be interpreted as richly metaphorical in the more inclusive, "acting as if," sense.[37] The global computer modelers in my essay on global environmental discourse, for example, think that human activity forms a system to be managed. More importantly, however, their categories, tools, diagrammatic conventions, gaming, and social positioning jointly enable them to act-- actually or in powerful fantasies--as if they were the planet's managers (or, at least, their close advisers).[38]

3. From an "existence" imaginary to "construction" work

In mathematics a distinction is made between existence and construction theorems. The former do their work by demonstrating, for example, that a system of equations governing some process will have one and only one point of equilibrium. A construction theorem takes on the more difficult task of laying out the steps or procedure needed to find that point. By analogy, early SSK tended to work within an existence imaginary. The existence of interpretive flexibility, for example, counters philosophical claims that, by rational procedures alone, scientists can allow nature to adjudicate among scientific claims. SSK tells us little, however, about how those particular claims came to exist rather than others. Not surprisingly, while SSK disturbs philosophers and scientists who had wanted to retain authority over representing scientific method, it rarely stimulates scientists to do science differently.

Similarly, cultural studies of S&T has thus far carried out its important oppositional work more within an existence imaginary than through "construction work." Against universalist accounts, cultural analysts argue that knowledge is situated, that there is a multiplicity of necessarily partial perspectives and voices implicated in S&T. Against simple determinations and firm foundations in reality, we are shown that there is a "mess"[39] of scientific practices and discourses taking place at sites that range from the psyche to the international political economy.[40] Ironic inversions upset literal interpretations and simple moral lessons; hybrids transgress foundational categories; science that promises enlightenment and liberation spawns confusions.[41]

In the different ways it points to the messy complexity of S&T's situatedness, cultural studies of S&T has already succeeded in disturbing people from both the SSK and scientific communities. From the defensive and even angry responses to cultural studies of S&T, it is clear that the SSKers and scientists alike had wanted to retain authority over representing scientific practice.[42] Yet, disturbing people is one thing; by what steps and practices, however, are science and the culture of science to be changed? The move from cultural studies of science to cultural politics is not straightforward. Who are the intended agents of change in a cultural politics of science? What are critical interpretive agents supposed to do with and through situating, cultural interpretation? If scientists are to be drawn into critical interpretive collaborations, how is this to be achieved? The explicit and implicit answers so far to these questions tend not to do justice to the situatedness (or heterogeneous constructedness) being interpreted. Nor do they make much of the warrant for practical reflexivity that follows from recognition of the situatedness of any interpretation.[43] Let me develop some examples outside this collection to tease out this assessment.

Andrew Ross invites us to join "a reasoned public discussion of issues concerning S&T," through which we expose the connections that exist among social, natural, and economic life, and articulate the different connections we might desire.[44] While public discussion of S&T is already and increasingly multivocal, Ross reminds us of the deep logic behind "technoculture": "capitalist reason, not technical reason, is still the order of the day."[45] By implication, socialists and others who see themselves resisting capitalist logic should be especially qualified and motivated to reason and discuss. David Hess, an anthropologist of S&T, also draws attention to techno(multi)culturalism. To challenge the power of the dominant social order and the S&T that contributes to it, he promotes solidarity with socially and scientifically marginalized groups. In particular, he argues, we should give attention to heterodox science and knowledge systems. Teaching about the multiculturalism of S&T should, moreover, help recruit and retain people from groups underrepresented in technical professions, and this would lead to different S&T.[46]

We have extracted these simple themes about agency and cultural politics from introductory and concluding material in books of Ross and Hess. While the body of their texts presents more complex pictures, their introductions or conclusions can sensitize us to the emergence of simple themes within more complex pictures and to the use of such themes as interpretive resources. In this spirit, let us note some discursive reductions and hidden determinisms in the accounts of some of the most complexity-embracing of writers, Traweek and Haraway.

Haraway and Traweek amplify Ross' and Hess' ideal of a wider,

multivocal discussions about technoculture. At the same time, they complicate oppositional solidarities by highlighting transgressions across the boundaries between marginal and dominant formations. Traweek, for example, describes a Japanese woman scientist in the male and US dominated field of high energy physics who used her experience in big multinational collaborations to identify "gleanings" of data left after the big boys took what they wanted. This woman then arranged a mutually beneficial deal with a computer company so she could build the equipment she needed to analyze those data.[47] However, within such stories of ambiguity lie some simpler themes.

Traweek associates her mess with a "phase transition" between eras.[48] Knowledges, technologies and societies have been based on simplicity, stabilities, uniformities, taxonomies, regularities and hierarchies. Now we are facing complexity, instabilities, variations, transformations, irregularities and diversity. Sometimes, however, she presents the second set of attributes as the way the world has always been; what has changed is the favored aesthetic of representation. I think we can attribute this equivocation to the greater rhetorical power of the claim that a marked (evolutionary) transition is occurring (to complexity, post-modernism, etc.). To grab our attention, to stimulate us to respond, it seems enough for Traweek to point to the new era of complexity (or to point to transgressions as evidence of its coming into

existence). In contrast, if we followed her shift in aesthetics interpretation, we would need to analyze the ongoing reconfiguration of knowledges, technologies, societies, and aesthetics in order to identify where and how to intervene. The mere existence of a transition provides little insight into pursuing this more difficult construction work.

The cultural politics to which Haraway's transgressors lead us is also interestingly ambiguous. Harvard patents a mouse that is transgenic, corporate and academic, natural and commodity, organic and technical--a cyborg.[49] Some cyborgs warrant scrutiny, especially those originally designed for war-making. Other cyborgs provide a transformative standpoint; like their kin, the Sister Outsider, Inappropriate/d Other, Coyote Trickster, and FemaleMan©, they are the marginal, dominated, silenced outsiders who move into areas previously off limits.[50] However, if Sister Outsiders provide special standpoints, why privilege situations in which they playfully, transgressingly negotiate change? Is transgression good? Why rule out havens or places of refuge, outside the dominant mess, in nurturing, organic communities? After all, Haraway's favoring of Sister Outsiders has helped enlist the allegiance of many who desire some solidarity and self-esteeem in their marginal positions.

We cannot find refuge in an organic unity for reasons that depend--at least, in my reading of Haraway--on inexorable commodification.[51] Once a

market is created where there was not one before, more and more people's lives are transformed by production and exchange of the commodity; there is no going back. Because we cannot escape this, Haraway invites us to become more self-consciously implicated in the process. But how are we to join in the market in ways that allow us to distinguish resistance from accommodation? While this question is not clearly answered in Haraway's complex accounts of "material-semiotic" production,[52] the implicit theme of inexorable commodification recalls a Marxist economic determinism, which would direct resistors to the necessity of class struggle. Yet the call to class struggle assumes that many differences among agents can be subordinated in the cause of more effective struggle against or resistance to dominant economic structures.

Haraway, Ross, Hess, and Traweek would not deny the limitations of class- or solidarity-based politics and are quite sensitive to the multiple dimensions of difference. Nevertheless, accounts that point to the existence of differences, ironies, transgressions, and other aspects of unruly complexity can still build on or build in complexity-collapsing concepts of politics. Whether this is one resource among many or dominates the accounts, there remains in cultural politics room for much more construction work.

4. To intermediate complexity between systems or unruly complexity

Traweek's mess, Haraway's clusters, and my unruly complexity are like supersaturated solutions; any object placed in them initiates precipitation. We could, in an effort to preempt discursive reductions and subvert any recourse to an unacknowledged determinism, try to lower into the solution some "grid" of intermediate complexity. We would want material to crystallize out of solution simultaneously along a distinct set of directions and along the interlinkages among those strands.[53] This combination would allow us to trace out the implications of the intersections of these strands. Let me make intermediate complexity concrete by continuing on the theme of commodification.

Commodification does appear almost inexorable; reversals seem rare. But suppose we take this putative determinism as something in need of explanation. After all, in a world of heterogeneous construction, we would expect commodification to be orchestrated, contested, and, at times, thwarted. This is evident in Schroeder's account (in this volume) of competing efforts to develop market gardens and fruit tree orchards.[54] Similarly, in another political ecological analysis, undertaken by a Mexican colleague, Raúl García Barrios, and his brother Luís, rich caciques supervised a stable moral economy of norms and reciprocal expectations among unequal, cooperating agents, and a stable agro-ecology of hillside terracing during the nineteenth

century in villages in Oaxaca, Mexico. This system both depended on and made possible their keeping the villages isolated from markets.[55]

The challenge that such political ecological analyses allow us to articulate better is exposing the construction of commodities, as well as the resistance to and reversals of such construction. The breakdown of this Oaxacan agro-ecology after the Mexican revolution is instructive. The revolution ruptured the moral economy by taking away the power of the caciques. Following peasant migration to industrial areas and semi-proletarianization of the rural population, village transactions became monetarized, and the collective institutions collapsed. The terraces began to erode. Goat herding, which was taken up because of its low labor requirements and was not regulated by strong local institutions, exacerbated the erosion. National food pricing policies that favored urban consumers meant corn was grown in the villages only for subsistence needs; maize remains to this day uncommodified.

--insert figure 1 about here--

Even in this very condensed sketch, we can discern the intersection of processes operating at different spatial and temporal scales, involving elements as diverse as the local climate and geo-morphology, social norms, work relations, and national political economic policy (figure 1). No one kind of thing, no single strand on its own could be sufficient to explain the

curently eroded hillsides. This contrasts with competing explanations that center on a single "dynamic," e.g., population growth as the cause of environmental change, or the power of capitalism and commodofiction to penetrate local economies. In the sketch I have also stepped away from debates centered around big oppositions, such as ecological versus economic rationality, or critical realism versus social constructivism.

While avoiding underlying determinisms and big oppositions, an account that identifies definite processes, which are then presented as intersecting, does abstract away some of the unruly complexity. The result is an intermediate complexity, which has implications for how one responds to potential commodification and, in the Oaxacan case, to environmental degradation. The intersecting processes account does not, for example, support government or social movement policies based on simple themes, such as economic modernization by market liberalization, sustainable development through promotion of traditional agricultural practices, or mass mobilization to overthrow capitalism. Instead, it highlights the opportunities for linking multiple, smaller and thus do-able interventions within the intersecting processes. However, to gain support for these interventions, including support in the form of linkage to other interventions, one would have to cultivate particular institutional and personal resources, agendas and alliances. By taking these particularities into account, it might be objected

that practically reflexive intermediate complexity would always dissolve back into some supersaturated solution. Possibly, but this remains to be seen--or, rather, to be worked out.[56]

5. From increasing to differential speed and extent

Schroeder's account of gardens and trees in the Gambia is also an account of agents who negotiate processes and mobilize resources that span the local and transnational, material and discursive, traditional and innovative. This picture will seem familiar to those in cultural studies who relate their subjects to the changing global or transnational order. Discussions of changes in the "new world dis/order" highlight the increasing extent of economic and cultural connections or, complementarily, their increasing speed. In technoculture, the icons of extent and speed are the internet and the ever accelerating project of genome sequencing.[57] In this context I want to suggest one last shift of positioning.

Consider William Cronon's widely read account of the nineteenth century emergence of a "Metropolis of Nature," the city of Chicago.[58] The picture he presents is of ever increasing speed and expanding extent. However, the motor of the changing capitalism he describes is not simply speed and increasing extent, but differential speed and extent. The futures

market, for example, takes off not simply because telegraphic communication connects the world more rapidly, but because some people in Chicago have access to that information well before and in greater detail than, say, farmers. Differentials provide a purchase for commodification processes in general. At the same time, they provide us a purchase for exposing the different and differentiating agents implicated in the orchestration and contestation of those processes.

By attending to differentials and differentiation, cultural studies can avoid static notions of difference or underlying determinisms. Moreover, this emphasis is completely consistent with the idea that boundaries will be problematic, transgressions abundant, and processes of different scales will intersect. It also consistent with the following, quite difficult challenge ahead for the cultural politics of S&T: To position different scientists and to position our different selves as knowers and interveners, we need ways to work with the unequal and heterogeneous practical and conceptual facilitations of sciences, technologies, and cultures.

A rough, on-going construction

The shifts involved in moving onto a terrain in which we address heterogeneous construction, acting as if, construction work, intermediate

complexity and differentials are, as I mentioned earlier, already underway in both cultural studies and STS. This afterword promotes these shifts, yet remains firmly within an existence imaginary. It does not clarify the intended agents of change in any specific case nor the steps or practices through which the science, technology, and culture is to be changed.

Taking into account the shifts of positioning still underway, the volume as a whole emerges as a necessarily a rough construction. The afterword resists the understandable tendency editors have to smooth over such roughness. Instead, I hope that readers position the work here as contributions, in need of clarification and extension, to intersecting projects in development. As declared in the introduction, the contributors to Changing Life seek, in a spirit of necessary partiality, to join with others changing life in a changing social dis/order. We hope that, through the many and diverse resources this collection provides, we are contributing to diverse interventions into processes linking genomes, ecologies, bodies and commodities.[59]

Captions

Figure 1. A schema of the socio-natural intersecting processes leading to soil erosion in San Andrés, Oaxaca. See text for brief description of this case and García-Barrios and García-Barrios, "Environmental and technological degradation," note 55, for more details. Dashed lines indicate connections across the different strands.

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[1] I gratefully acknowledge the comments and suggestions of Ann Blum, Paul Edwards, Saul Halfon, Stefan Helmreich, Bill Lynch, Andrew Ross and Joe Rouse made in response to drafts of this essay.

[2] When I use the label STS and refer to its constituent disciplines I am thinking mostly of the academic fields of sociology, history, anthropology, politics and philosophy of science and technology. One of the aims of this essay and the volume as a whole is, however, to expand the range of scholars who identify with the STS label. And similarly for the label of cultural studies (see the section in the text on Science and technology as culture for an overview of what I consider to be the salient characteristics of cultural studies). I intend my points to be relevant and challenging generally to scholars who identify with one or both of these areas. At the same time, I realize that specific sectors of STS and cultural studies have in their own ways already tackled some of the issues in greater depth than I can do justice to here.

[3] Other recent anthologies linking cultural studies and STS include: Stanley Aronowitz, Barbara Martinsons, and Michael Menser, eds., Technoscience and Cyberculture (New York: Routledge, 1995); Chris H. Gray, ed., The Cyborg Handbook (New York: Routledge, 1995); Gary Downey, Joseph Dumit, and Sharon Traweek, eds., Cyborgs and Citadels: Anthropological Interventions on the Borderlands of Technoscience (Seattle: University of Washington Press, 1996).

We acknowledge in the introduction to this volume the leadership role of Donna Haraway and Sharon Traweek in developing the exchange between STS and cultural studies. I take the liberty in this afterword of refering, sometimes critically, to their work to help me articulate the shifts that have been made and the further shifts I propose.

[4] Harry M. Collins, "Review of Bruno Latour, We Have Never Been Modern" Isis 85, no.4 (1994): 672-674; Peter R. Dear, "Cultural history of science: An overview with reflections," Science, Technology & Human Values 20, no.2 (1995): 150-170.

[5] In this light, I use the term epistemology to refer to concerns about how various agents, not only scientists, establish knowledge claims and

interpretations. Moroever, as will become evident, knowledge-making is treated as inextricably connected with a wide range of other practices.

[6] For alternative descriptions of cultural studies as this field relates to science, see Traweek, "Introduction"; Hess, David, Science and Technology in a Multicultural World: The Cultural Politics of Facts and Artifacts (New York: Columbia University Press, 1995); Michael Menser, and Stanley Aronowitz, "On cultural studies, science, and technology," in Technoscience and Cyberculture, ed. Aronowitz et al., 7-28; Gary Downey, Joseph Dumit, and Sharon Traweek, "Locating and intervening," in Cyborgs and Citadels, ed. Downey et al.; Joseph Rouse, "What are cultural studies of scientific knowledge?" Configurations 1, no.1 (1992/3): 1-22, and Engaging Science: How to Understand its Practices Philosophically (Ithaca, NY: Cornell University Press, 1996).

[7] Harry M. Collins, "Stages in the empirical programme of relativism," Social Studies of Science 11 (1981): 3-10.

[8] Some scholars in STS and cultural studies oppose the goal of explanation. See Rouse, "What are cultural studies;" and Engaging Science; Hess, "Science and technology"; and Bruno Latour, "The politics of explanation: an alternative," Knowledge and Reflexivity: New Frontiers in the Sociology of Knowledge, ed. Steve Woolgar (London: Sage, 1988),155-176. What they oppose is only one particular form of explanation, in which a range of

outcomes in one variable realm (e.g., science) are tied to some feature of a relatively stable realm (society). This opposition is based on: a) (correctly in my view) not seeing social life as stable or as a realm separate from science; and b) wanting to highlight the novel coalitions and outcomes involved in the production of science and society. However, the accounts of networks of resources or webs of meaning that they advocate build on multiple, diverse causes; see, e.g., Bruno Latour, Science in Action: How to Follow Scientists and Engineers through Society. (Milton Keynes: Open University Press, 1987). Rouse and Hess also want to shift explanation out of the center of STS's focus (and perhaps out of the picture altogether) arguing that this is necessary in order to make room for reflexive, politically engaged practice. I agree with this last goal, but prefer to rework explanatory practice, rather than to act as if one were abandoning it. For further discussion of these points, see text below and the appendices to Peter J. Taylor, "Building on construction: An exploration of heterogeneous constructionism, using an analogy from psychology and a sketch from socio-economic modeling," Perspectives on Science 3, no.1 (1995): 66-98.

[9] Donna J. Haraway, "High Cost of Information in Post-World War II Evolutionary Biology: Ergonomics, Semiotics, and the Sociobiology of Communication Systems," Philosophical Forum XIII, nos. 2-3 (1981-82): 244-279; "Signs of dominance: From a physiology to a cybernetics of primate

society," Studies in History of Biology 6 (1983): 129-219; "Teddy bear patriarchy: Taxidermy in the garden of Eden, New York City, 1908-1936," Social Text 11 (1984/1985): 20-64.

[10] Raymond Williams, "Ideas of nature," Problems in Materialism and Culture (London: Verso, 1980), 67-85. It should be noted that Williams was, in most accounts, one of the important early figures in British cultural studies.

[11] Of the essays in this collection see, in particular, those of Gilbert, "Bodies of knowledge," and Haila, "Discipline or solidarity? Ecology as politics."

[12] For example, organismic metaphors in social and biological thought gave way after World War 2 to both cybernetic and individualistic metaphors. See Haraway, "High cost of information"; Peter J. Taylor "Technocratic Optimism, H.T. Odum, and the Partial Transformation of Ecological Metaphor after World War II," Journal of the History of Biology 21, no.2 (1988): 213-244; Gregg Mitman, "Defining the organism in the welfare state: The politics of individuality in American culture, 1890-1950," Social Sciences Yearbook XVIII (1994): 249-280. In the life sciences, ecology has come to co-exist with both the environmental movement and the industry of environmental management. In social thought more generally the organic community under threat during the Great Depression was eclipsed by post-WWII optimism about preventing "violent oscillations" through efficient systems of feedback, communication and command/ control. This optimism

is now tempered, yet life continues to be reconstructed, ever more intimately and extensively.

[13] See, for example, Helmreich, "Replicating reproduction." Bill Lynch and Joe Rouse (pers. comm.; see also Rouse, Engaging Science) reminded me that an alternative reading of these discursive interpretations is that shared metaphors and so on are just those aspects of language, conceived of as an extra-individual phenomenon, that people know how to react to. In principle, people do not have to be seen as carrying the metaphors around inside their heads. A combination of or equivocation between these two readings is, for example, evident in Lily Kay, "A book of life? How a genetic code became a language." Controlling Our Destinies, ed. Philip Sloan (Notre Dame: University of Notre Dame Press, 1997), in press. In practice, I believe, many interpreters of science fit my reading better than Lynch and Rouse's. This can be the case, moreover, even for interpreters who insist on the emergence of meaning from the patterns and messiness of interactions among agents. When they omit discussion of how agents actually make their work, their accounts also become readable in terms of society-internalized-in-subjectivity . See the discussion of meta-metaphors in the text and notes below.

[14] This was one of the motivating themes of the conference sessions from which this volume originated on "Changing Life in the New World

Dis/order," held at the July 1993 meetings of the International Society for History, Philosophy and Social Studies of Biology, Brandeis University.

[15] From the cultural studies angle (see the section, Science and technology as culture, above), there might seem to be little reason to keep the focus on scientists, or, at least, not on mainstream scientists. Abundant material is provided by examining S&T as they are invoked in wider cultural arenas by diverse social groups. See Ross, Strange Weather; Hess, Science and Technology. I note, however, that when cultural analysts of S&T attend to the reception of science more than to its production, they risk implying that scientists' practice and theories are indefinitely malleable. In any case, in the text to follow I will shortly extend my category of agents to include interpreters as well as scientists.

[16] Dear, "Cultural history"; Steve Shapin, Social History of Truth: Civility and Science in Seventeenth-century England (Chicago: University of Chicago Press, 1994).

[17] SSK has been most illuminating when focused on specific sites and junctures, especially laboratory experiments and other disputes over the reliability of knowledge. Regulation, new social movements, and transnational discourses do enter the SSK work of, for example, Jasanoff, Wynne, Yearley; see Sheila S. Jasanoff, Gerald E. Markle, James C. Petersen, and Trevor J. Pinch, eds. Handbook of Science and Technology Studies

(Thousand Oaks: Sage, 1995). The historical work of Simon Schaffer and his students at Cambridge University might--depending on one's definition of SSK--also be subverting my generalization about SSK; see, for example, Simon Schaffer, "Babbage's intelligence : Calculating engines and the factory system," Critical Inquiry 21, no.1 (1994): 203-227.

[18] Epistemology is construed here in the broad sense described in note 5.

[19] Sharon Traweek, "Worldly diffractions: Feminist and cultural studies of science, technology, and medicine," presented at the annual meeting of the American Sociological Association, Los Angeles, August 1994.

[20] Sandar Harding, Whose Science? Whose Knowledge? Thinking From Women's Lives (Ithaca: Cornell University Press, 1991); Sergio Sismondo, Science without Myth: On Constructions, Reality, and Social Knowledge (Albany: SUNY Press, 1996).

[21] Donna J. Haraway, "Situated knowledges: The science question in feminism and the privilege of partial perspective," Feminist Studies 14, no.3 (1988): 584. Sociologist of science, Thomas Gieryn has observed that Comte developed a working class standpoint theory; "Objectivity for these times," Perspectives on Science 2 (1994): 324-349. Comte proposed, for example, that: "The working class is better qualified than any other for understanding, and still more for sympathizing with, the highest truths of morality"; Gertrud

Lenzer, ed., <u>Auguste Comte and Positivism: The Essential Writings</u> (New York: Harper and Row, 1975), 351.

[22] Haraway, "Mice into wormholes." See also "Situated knowledges: The science question in feminism and the privilege of partial perspective," <u>Feminist Studies</u> 14, no.3 (1988): 575-599.

[23] Latour, <u>Science in Action</u>; John Law, "Technology and heterogeneous engineering: The case of Portugese expansion," <u>The social construction of technological systems: New directions in the sociology and history of technology</u>, ed. Wiebe E. Bijker, Thomas P. Hughes, and Trevor J. Pinch (Cambridge, MA: MIT Press, 1987), 111-134.

[24] Unlike Callon, Latour, and others, I will not embrace non-humans in our discussion of agency, because this move tends to reduce human agency to a lowest common denominator. See Peter J. Taylor, "What's (not) in the mind of scientific agents? Implicit psychological models and social theory in social studies of science," presented at the annual meeting of the Society for Social Studies of Science, West Lafayette, November 1993. The resistance of non-living things and the agency of non-human organisms can be addressed in terms of the difficulty human agents have in mobilizing resources.

[25] My use of this loaded term is intended to preserve connotations of construction as a process of building from materials, but to downplay connotations of constructions as ideas reflecting or corresponding to some social position; Taylor, "Building on construction." I am not, as it is still obligatory to note, advocating unbridled relativism. I accept that close correspondence between knowledge and some underlying reality can be a significant resource in heterogeneous construction. The point, however, is that practice is never determined by any single kind of resource.

[26] Associating imagination and the labor-process is an idea of Marx. See <u>Capital,</u> vol. 1, pt. 3, chap. 7, sec. 1, reprinted, e.g., in Robert C. Tucker, ed., <u>The Marx-Engels Reader</u> (New York: Norton, 1978), 344–45. See Stephen Robinson, "The art of the possible," <u>Radical Science Journal</u> 15 (1984): 122-148 for a relevant discussion of this passage.

[27] Peter J. Taylor, "Re/constructing socio-ecologies: System dynamics modeling of nomadic pastoralists in sub-Saharan Africa," <u>The Right Tools for the Job: At work in twentieth-century life sciences</u>, ed. Adele Clarke, and Joan Fujimura (Princeton: Princeton University Press, 1992), 115-148; Taylor, "Building on construction."

[28] We should not be using "complexity" without discussing its recent history (see Hess, <u>Science and Technology</u>, 106-116 for a schematic overview), which centers around non-linear dynamics and cellular automata; George Cowan, David Pines, and David Meltzer, eds., <u>Complexity: Metaphors, Models, and Reality</u> (Reading, MA: Addison-Wesley Pub. Co., 1994). I will, however, only note that the picture of "unruly complexity" to follow fits

neither of two alternative foundational principles for theories of complexity: simple rules lead to complex behaviors, or macro-regularities can arise statistically from large numbers of similar entities.

[29] Taylor, "Re/constructing socio-ecologies" and "Building on construction." Other scholars take this complexity as a warrant for breaking away from epistemological concerns, or, at least, from the associations attached to the label epistemology; see Rouse, Engaging Science.

[30] This picture is developed in the context of social-ecological relations in Peter J. Taylor and Raúl García-Barrios, "The social analysis of ecological change: From systems to intersecting processes," Social Science Information 34, no.1 (1995): 5-30.

[31] See my essay, "How do we know we have global environmental problems" in this volume. The call for reflexivity regarding STS' own interpretations has been a theme in sociology of science for over a decade; see Steve Woolgar, ed., Knowledge and Reflexivity: New Frontiers in the Sociology of Knowledge (London: Sage, 1988); Malcom Ashmore, The Reflexive Thesis : Wrighting Sociology of Scientific Knowledge (Chicago: University of Chicago Press, 1989). The emphasis in reflexive STS (and cultural studies), however, has been on the textual and rhetorical strategies used to advance an argument or interpretation. Downey et al., "Introduction" and Menser and

Aronowitz, "On cultural studies" also promote reflexivity about unraveling the "knots" of technoculture.

[32] See, e.g., Shapin, Social History, xv.

[33] The anthropologist Eric Wolf critiques this in his Europe and the People Without History (Berkeley: University of California Press, 1982), 385-391: "Societies emerge as changing alignments of social groups, segments, and classes, without either fixed boundaries or stable internal constitutions... Therefore, instead of assuming transgenerational continuity, institutional stability, and normative consensus, we must treat these as problematic. We need to understand such characteristics historically, to note the conditions for their emergence, maintenance and abrogation." (Wolf, 387)

[34] Menser and Aronowitz, "On cultural studies," 17.

[35] Menser and Aronowitz, "On cultural studies," 24.

[36] Timothy Mitchell identifies a master metaphor in social theory, the distinction between persuading and coercing. He observes that this dualism, which opposes meaning to material reality, underwrites most strategies of power; Timothy Mitchell, "Everyday metaphors of power," Theory and Society 19 (1990): 545-577. In STS and cultural studies, an analogous deep split is that between believing and acting, representing and intervening. Mitchell's account of this master metaphor's persistence might be read as a comment on the difficulties of shifting from mental and verbal images to

"acting as if" as an interpretive meta-metaphor: "One [reason for the persistence] stems from the fact that [the master metaphor] is indissociable from our everyday conception of person[s]... as unique self-constituting consciousnesses living inside physically manufactured bodies. As something self-formed, this consciousness is the site of an original autonomy... [which] defies the way we think of coercion. It obliges us to imagine the exercise of power as an external process that can coerce the behavior of the body without necessarily penetrating and controlling the mind" (ibid, p. 545).

[37] To a large degree this point matches the emphasis of Haraway and others in cultural studies of S&T on the relationship of metaphors to concrete ways of dealing with things (thus her "material-semiotic actors"; see Haraway, "Situated knowledges"). The predominant choices of metaphor for likening, however, suggests that more work is needed to move beyond mental and verbal construals of metaphor and of action.

  In my reading the literature that analyzes in general (as against in specific instances) the use of metaphors has been dominated by three related meta-metaphors: 1) metaphors are root, fundamental, underlying things that shape the surface layers; 2) mental things--thoughts, expectations, what we see-- shape our actions; and 3) culture or society gets into these thoughts etc. (and so we can be taught how to conceive/ perceive the world). These meta-metaphors are not helpful for developing the idea that all action and thought is constructed in practical activity from heterogeneous resources. For examples of the dominant meta-metaphors see Kurt Danzinger, "Generative metaphor and the history of psychological discourse, and Kenneth J. Gergen, "Metaphor, metatheory, and the social world," in Metaphors in the History of Psychology, ed. David E. Leary (Cambridge: Cambridge University Press, 1990), 331-356 and 267-299, respectively; George Lakoff, "The contemporary theory of metaphor," and Michael Reddy, "The conduit metaphor: A case of frame conflict in our language about language," in Metaphor and Thought, ed. Andrew Ortony (Cambridge: Cambridge University Press, 1993), 202-251, and 164-201, respectively; Nancy Leys Stepan, "Race and gender: The role of analogy in science," Isis 77 (1986): 261-277.

[38] Taylor, "Technocratic optimism, and "Re/constructing socio-ecologies"; Peter J. Taylor and Ann S. Blum, "Ecosystems as circuits: Diagrams and the limits of physical analogies," Biology & Philosophy 6 (1991): 275-294.

[39] Traweek, "Worldly diffractions."

[40] See the quote from Traweek at the start of shift 1.

[41] See, for example, the essays in this volume by Cole, "Do androids pulverize tiger bones to use as aphrodisiacs?"; and Love, "Bubbles in the cosmic saucepan". In fact, the force of the existence imaginary is evident in most of the essays of Changing Life.

[42] On the SSK side see Collins, "Review of Bruno Latour," Dear, "Cultural history of science," and Trevor J. Pinch, "Review of Hess and Layne, The Anthropology of Science and Technology," Isis 86, no.2 (1995):358. On the scientist side see Paul R. Gross, and Norman Levitt, Higher Superstition: The Academic Left and its Quarrels with Science (Baltimore: Johns Hopkins University Press, 1994); Meredith F. Small, "Review of Primate Visions, by D. Haraway," American Journal of Physical Anthropology 85 (1990): 527-528. See also the responses to the hoax played by physicist Alan Sokal in Social Text 46/47 (1996). For example, see the letters written to the New York Times, 23 May 1996, A28.

[43] The specter of the literary and legal critic, Stanley Fish, haunts me as I pursue this line of questioning. Although a master of exposing the situatedness of interpretation, he argues against making any connection between becoming "more self-consciously situated [and] inhabit[ing] our situatedness in a more effective way"; "Anti-foundationalism, theory hope, and the teaching of composition," Doing What Comes Naturally: Change, Rhetoric, and the Practice of Theory in Literary and Legal Studies (Durham: Duke University Press, 1989), 347. He seems to be looking for connections that would have the status of guarantees, the stuff, ironically, of foundationalists. Granted, awareness of the constraints on one's situation does not automatically relax those constraints (ibid, 351), but this has no logical bearing on the empirical and practical question: When and how can systematic reflection on one's situatedness become a resource facilitating reconstruction of one's work? Despite Fish's error in logic, his argument invites attention to his situatedness. At the same time, the popularity of his argument invites attention to the situatedness in the politics of the 1990s of anyone trying to connect politics and analyses of situatedness (see also Downey et al., "Introduction"). (As Bill Lynch reminded me, the popularity during the 1980s of exposing the situatedness of interpretation also invites interpretation, but this is more a matter of historical interest.)

[44] Ross, Strange Weather, 13.

[45] Ross, Strange Weather, 10.

[46] Hess, Science and Technology, chapters 1 and 9.

[47] Traweek, "When Eliza Doolittle studies."

[48] Sharon Traweek, Lecture given to the Department of Science and Technology Studies, Cornell University, Ithaca, NY, 26 April 1993. See also her Turbulent Phase Transitions in Japanese and American High Energy Physics, forthcoming.

[49] Haraway, "Mice into wormholes."

[50] Recall also Traweek's Japanese woman high energy physicist in "When Eliza Doolittle studies." The kin listed here are borrowed and adapted by Haraway respectively from Audre Lorde, Trinh Minh-Ha, Native American

myths, and Joanna Russ. See Donna J. Haraway, "Manifesto for cyborgs: Science, technology, and socialist feminism in the 1980s," Socialist Review 80 (1985): 65-107, "Promises of monsters," "Mice into wormholes." See also Edwards' essay on cyborgs in this collection and Gray, Cyborg Handbook.

[51] In "Promises of monsters" Haraway speaks of "relentless artifactualism." I read this as a combination of two themes: a) humans (and other organisms, especially primates) are heterogeneous constructors; and b) commodification is inexorable.

[52] Haraway, "Situated knowledges."

[53] Or, using a metaphor of Haraway's, to tease out particular strands of the "cat's cradle," but not to tear them out. Donna J. Haraway, "A game of cat's cradle: STS, feminist theory, cultural studies," Configurations 2, no. 1 (1994): 59-71.

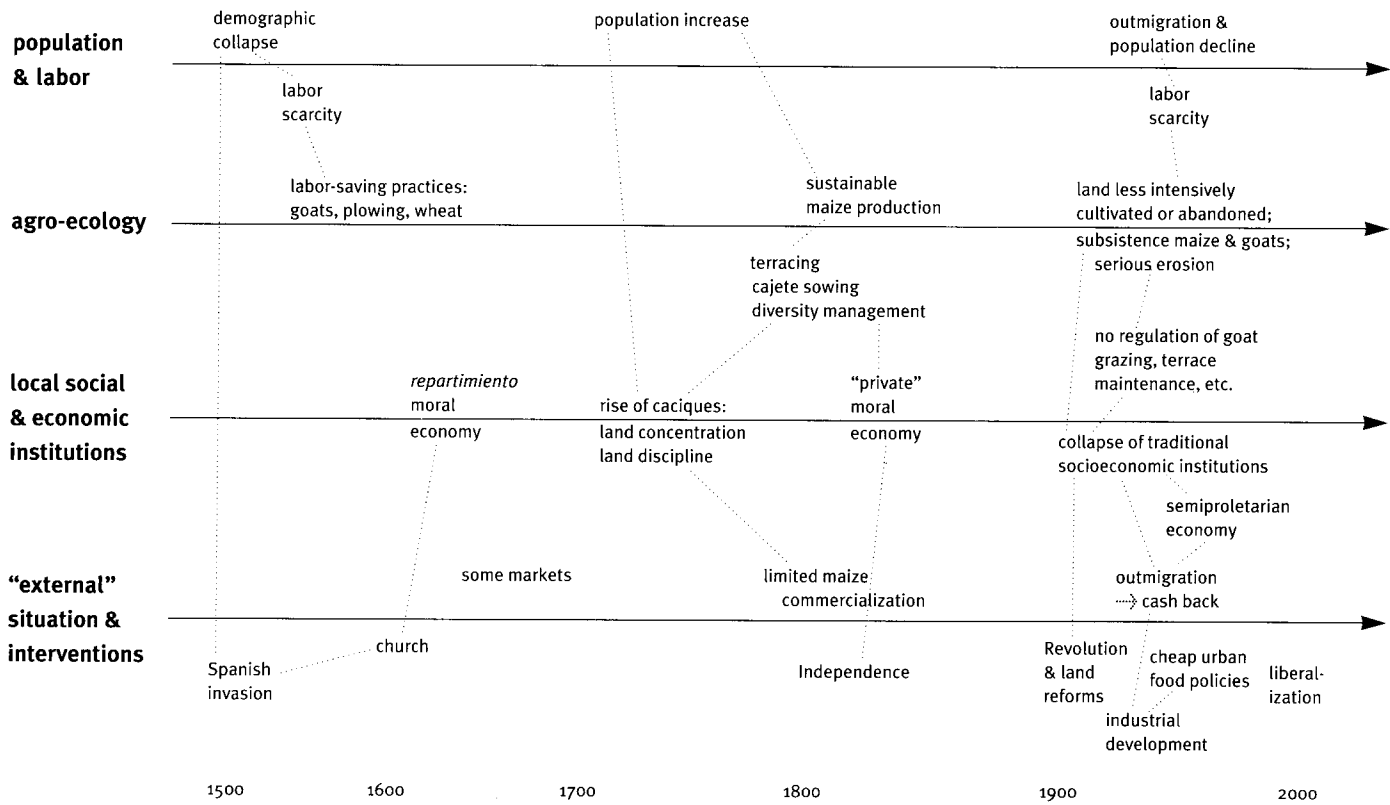[54] Richard Schroeder, "Contradictions along the commodity road to environmental stabilization."

[55] Raúl García-Barrios, and Luis García-Barrios, "Environmental and technological degradation in peasant agriculture: A consequence of development in Mexico," World Development 18, no.11 (1990): 1569-1585. For an overview of political ecology, see Richard Peet, and Michael Watts, "Introduction: Development theory and environment in an age of market triumphalism," Economic Geography 69, no. 3 (1993): 227-253.

[56] Indeed, much remains to be worked out; this image of intersecting processes is not sharply defined. Let me just stress that it is not meant to valorize small interventions; these might be at cross purposes to other small interventions, and, unless local interveners have complementary visions of the larger intersecting processes, never combine into anything significant.

[57] Michael Fortun, "Projecting speed genomics," The Practices of Human Genetics: International and Interdisciplinary Perspectives (Sociology of the Sciences Yearbook Vol. 19), ed. Michael Fortun, and Everett Mendelsohn (Boston: Kluwer, 1996).

[58] William Cronon, Nature's Metropolis: Chicago and the Great West (New York: Norton, 1991).

[59] For allied contributions see notes 3 and 6 and work cited in the introduction to this volume.

population & labor

demographic collapse — population increase — outmigration & population decline

labor scarcity — labor scarcity

agro-ecology

labor-saving practices: goats, plowing, wheat — sustainable maize production — land less intensively cultivated or abandoned; subsistence maize & goats; serious erosion

terracing cajete sowing diversity management

no regulation of goat grazing, terrace maintenance, etc.

local social & economic institutions

repartimiento moral economy — rise of caciques: land concentration land discipline — "private" moral economy — collapse of traditional socioeconomic institutions

semiproletarian economy

"external" situation & interventions

some markets — limited maize commercialization — outmigration ---> cash back

Spanish invasion — church — Independence — Revolution & land reforms — cheap urban food policies — liberalization — industrial development

1500   1600   1700   1800   1900   2000