
Chapter 5: Present and Future TBL: Change — The Only Constant in Life

Things change over the generations: as much in respect of our substantially changing views on engineer Gantt's sincerest of intentions for the good of Society, as in flipping the fundamentals of what amounts to {environmental benignity} from a good to a bad and *vice versa*. Were the virtue of upcycling reactive N-species to be taken to its logical conclusion, for example, this could turn eutrophy from a bad to a good (and oligotrophy conversely so), especially in the face of other disturbances, such as climate change and the invasion of exotic species (Schertzer and Lam, 2002). The possibly quite unattractive notion of releasing muted pollution events to rivers, as pre-emptive vaccination against future insults and injury, might instead be re-cast as the good of beneficial nutrient supplements: for the purpose of spectrum reconstruction and thereby restoration, even enhancement, of ecosystem services.

If the long view is long enough — as it must be in respect of sustainability — such flux and strategic change will have a continual bearing upon on how we decide (now) to move forward. “Change” will indeed be “the only constant in life”.

We stand amidst these things, then:

A bewildering plethora of indicators for what constitutes sustainability.

An ever-expanding volume of knowing about the behavior of the ever larger in natural systems, as in the “thinking globally” of Earth Systems Analysis (Figure 1), and the behavior of the ever smaller in human systems — as in neuroscience, brain function, hence human motivation — ergo “acting locally” (Figure B2.1).

A growing awareness — because increasingly we are taking the long view — of the impermanence of what was once thought constant (the statistical properties of meteorology, for instance), even surprise at the preposterous suggestion (for some) that what was deemed bad for the environment less than two generations ago (eutrophication) might well today be seen (by others) as not so bad after all.

Let us therefore acknowledge that the outcome to be achieved by the close of our *Sustainability Concepts Paper* will inevitably be hopelessly incomplete.

And yet, in spite of our predicament — the ever shifting foundations of knowledge, the ever expanding purview — can we erect any signposts to chart progress through the tangled complexity of the real world, framed within the terms of the Triple Bottom Line (TBL)? In essence, can we map all of the foregoing discussion of *concepts* as succinctly as possible onto some kind of template within the *N*-dimensional space of sustainability assessments as presently conducted in practice? Can we even say something of how the criteria of these assessments might change over time?

We have three purposes, therefore:

- (i) To summarize the most frequently cited components of today's applications of TBL thinking (the TBL_{now} , say) for achieving, in particular, sustainability of IUWM within IWRM. These are, or are becoming, the custom and convention in assessing sustainability.
- (ii) To introduce some strong, if not bold, conjectures about how to organize the guiding threads of thinking underpinning these components of the TBL_{now} ; to reduce these threads in turn to their most elementary parts, collectively the “axes” of the *N*-dimensional assessment space; thus to extract a skeletal template of what might become such thinking on sustainability assessments generations hence, which we shall consider as the scaffolding for a TBL_{future} . In short, we seek to construct a logic for the manner in which the ensemble of line items in the TBL_{now} might evolve over the longer term to embrace those of a TBL_{future} .
- (iii) To identify progress at the frontiers of contemporary practice, i.e., to capture a snapshot of the $TBL_{frontier}$, illustrating how our communities and professionals are stepping out from the TBL_{now} en route to features dimly discernible within TBL_{future} , which further practice (and research) should seek to

clarify, adapt, and — as need be — change. To this will an entire chapter be devoted (Chapter 6).

Each of the TBL_{now} , TBL_{future} , and $TBL_{frontier}$ will in due course be associated with its own tabulated material.

Both Constant Revolution and Consistent Routine

We recognize a strong counter-current to the setting out of this spread of threads: the urge, that is, to boil all of the “tangled complexity of the real world” down to an invariant TBL_{∞} ; a TBL_{∞} , moreover, that is quantified and scalar, just a single number (Krajnc and Glavič, 2005).

There are indeed persuasive, practical reasons for wanting invariance (over time) in the accountancy of the TBL. People wish to discriminate in what projects and enterprises they will invest their time, energy, and funds (or not); and projects and enterprises will seek to attract such “buy-in”. Evidence and promises of delivering “more” and “more swiftly” in respect of moving away from unsustainability must, we acknowledge, be judged on a strictly consistent basis.

But why should we expect the criteria of the TBL to be invariant, especially over the longer term, which — need it be said (again) — is defining for sustainability? If all else around us is changing, why should we expect convergence upon an immutable set of line items for the TBL, i.e., a TBL_{∞} ?

Writing of the single bottom line of profit and loss — the one we all knew of before he was credited with coining the phrase “triple bottom line” — Elkington (2001) observed:

Despite 500 years — some people, counting early clay tablets, would say at least 5000 years — of evolution in mainstream accounting, there remain huge controversies over how companies account for acquisitions and disposals, record extraordinary and exceptional items, value contingent liabilities, capitalize costs and depreciate their assets.

The instinctive urge towards consolidation and convergence, to crystallize out that much sought-after, succinct operational definition of sustainability, can nevertheless obscure the apprehension, comprehension, and exploitation of change. Both change and constancy are, of course, worthy. The tension between them —

between the flux and discomfort of constant revolution and the invariance and comfort of consistent routine — should be creative. We need the comfort of “knowing” and the discomfort of “knowing that that ‘knowing’ is never quite right”.

5.1 From TBL_{now} to TBL_{future}

Tables 1 and 2 set out respectively those components of the TBL apparent and applicable in practice today (TBL_{now}) and companion components we can presently imagine as becoming candidates for application in the (longer-term) future (TBL_{future}). They are measures of how far we have come (Table 1) and how far there is still to go (Table 2). The TBL_{future} is not meant to replace or do away with the TBL_{now} , but evolve from it and, in particular, enrich it. Where there is mystifying difference between corresponding cryptic entries in Tables 1 and 2, seemingly without logic, it is the purpose of what follows to establish the thread of understanding that unites them.

Table 1, then, is based largely on the work of Balkema *et al* (2002), Jeppsson and Hellström (2002), and Hellström *et al* (2000). Supplementary material is drawn from Sahely *et al* (2005), Ashley *et al* (2008), Starkl *et al* (2009), and Sharma *et al* (2009), who consolidate much of what preceded their own contributions.⁵² All, however, have been tailored to the needs of what we are calling IUWM herein. Between Tables 1 and 2, therefore, is an expansion in scope from IUWM to IWRM. This, in itself, is a significant part of the difference between the TBL_{now} and TBL_{future} .

Striking should be the fact that the tabulated line items (or threads) can neither neatly nor crisply be categorized as belonging to {social legitimacy}, {economic feasibility}, or {environmental benignity}. The strong temptation to separate them into three identifiable blocks of row components has been resisted, precedent and the structure of Chapter 3 notwithstanding. The sequence of these line items has a quite deliberate logic, nonetheless. It proceeds from top to bottom: from matters of the very local, personal, and human-centered, to matters economic, then environmental, and eventually to matters of a more global character. Considerations unfold thus in much

⁵² Starkl *et al* (2009) and Sharma *et al* (2009), we note, were the other two recipients of the 2008 IWA Prizes for theoretical progress in Sustainability in the Water Sector (alongside Ashley *et al*, 2008). Stepping back into the record of published works on sustainability, and stepping outside the water sector, it should also be noted how perspicacious was the study of Azar *et al* (1996). Amongst other insights, they sought to form early-warning, social indicators for maintaining a healthy balance in the metabolism of what they called the technosphere, between the lithosphere and the ecosphere.

the same manner as they do in the person-centric perspective of Figure B2.1 in Box 2.

Plotting Enrichment and Change

The fourteen rows are present in the structure of each table, for consistency in thinking from the present to the future and for comparing theory with practice. Around them, i.e., the tabulated line items of (T1) through (T14) below, we have re-organized the consensus of others (in Table 1). They are the warp and weft of our fabric of the TBL herein: less rigid than any companion, quantitative metrics; just as incomplete as any distant TBL_{∞} on which we might be converging, albeit asymptotically; yet something, nevertheless, with which to tame the rambling and tangled complexity of thinking about sustainability. They tie Table 1 (TBL_{now}) to Table 2 (TBL_{future}), and both to Table 3, with its path-breaking elements of the TBL at the frontiers of practice ($TBL_{frontier}$; in Chapter 6).

Fourteen threads for guidance seems enough. Yet even these do not suffice as a foundational matrix of “orthogonal axes” — adequately strengthened by that very quality of non-duplicate, unconfused, non-conflated orthogonality — with which to dare to extrapolate from a TBL_{now} to a TBL_{future} . We have to contend with two essential difficulties: (i) the ever-expanding purview of what constitutes sustainability; and (ii) the ever-evolving intricacy, subtlety, sophistication, complexity, and richness of what might be included in that purview. Figure 16 establishes how we propose to do so, across all the line items of our TBL.

First, according to Figure 16(a) there are provinces for the “wealth” of the analysis or assessment, bounded at its left by what we might usually label an origin, but which here we shall generally refer to as the pole or corner of “poorness” or “poverty” of coverage or thought (boundary (U), for “unrefined”). Along the axis are graduations marking successively wealthier (more extensive, more subtle) assessments as one moves rightwards to the boundary marked “rich”. And this is a boundary, i.e., (R) for “refined” in Figure 16(a). It is one that decidedly does not indicate some hypothetical, infinitely rich coverage of analysis.

To assist in grasping our usage of the bounds of this span of wealth of assessment in Figure 16(a), “poor” can be equated roughly with “crude”, “thinness of thought”, “impoverished”, “simple”, “singularity”, or “coarse net/

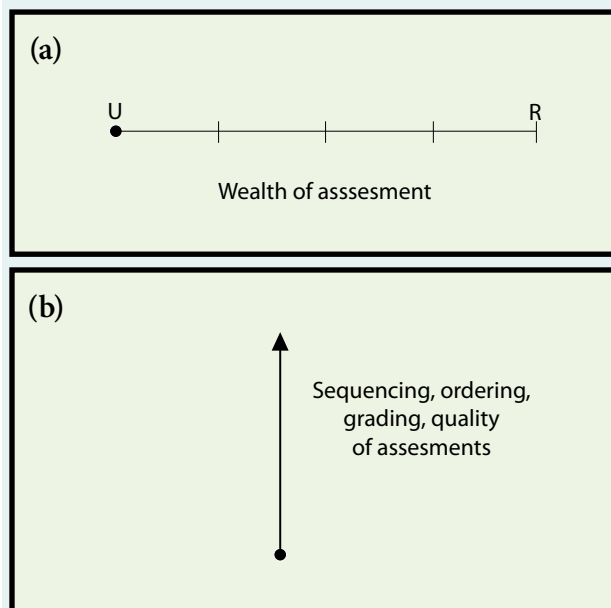


Figure 16

Axes for plotting enrichment of assessment and change (from TBL_{now} to TBL_{future}): (a) graduated provinces covering wealth of assesment between the bounds of poor, rudimentary, or unrefined (U), and rich, subtle, or refined (R); (b) familiar directional axis for gauging quality in some manner. A specific instance employing the two types of axis follows in Figure 17.

mesh”. “Rich” can likewise be understood alternatively and respectively by the counterpart words of “subtle”, “depth of thought”, “complex”, “plurality”, or “fine net/mesh”. The primary purpose in introducing and using these terms is that of aiding the reader’s appreciation of how some TBL_{future} might enrich what is currently practiced through the TBL_{now} . To cast thereby some slur on this latter is not the intent. Simplicity is very often a virtue; while attempting to go beyond the rightward boundary of complexity clearly has its disadvantages. These are neatly summed up in the old saw about the “mental paralysis of the systems analyst”, who is unable to think through something because s/he perceives everything to be related to everything else, which it is, of course. Paralyzed thereby, this systems analyst is unable to draw a line around what is to be included in the analysis and what excluded from it, in order actually to start the analysis.⁵³

⁵³ The skeptical reader presently lost in the thicket of this discussion may well think that I can neither see nor appreciate the simplest, fastest, and most pragmatic route from A to B. And I might have some sympathy with that reader.

Figure 16(b) shows a directional axis, with an arrowhead. It will be the more familiar of the two axes and is probably what one would expect of a *Concepts Paper* about “moving away from unsustainability and towards sustainability”. We sequence, order, and grade things all the time: Maslow’s pyramid in (T1) below (Maslow (1943)); Arnstein’s ladder in (T2) (Arnstein (1969)); something to be attained now, something else later; something better, and something yet better still; and so on.

Counter-intuitively, perhaps, the majority of the axes to be introduced in the following — to assist appreciation of the threads of logical connections amongst the cryptic entries in Tables 1, 2, and 3 — will be ones of the style of Figure 16(a), not Figure 16(b). Maslow’s (putative) pyramid and Arnstein’s ladder are rather the exception, accompanied equally exceptionally by a directional axis of “deliberative quality” in governance (T4). On the other hand, there can be a sense of desirable direction, rightward along the wealth axis of Figure 16(a). We shall encounter such in respect of ethics and equity under (T5), in that we should care about more things in the world than the self alone — a richness as opposed to a poverty of thought (and spirit), in other words. For that is the essential exhortation in our attempting to become less unsustainable.

Our journey through the fourteen threads of the TBL will begin with the most local, intimate, and personal of considerations. The device of the axes of Figure 16 will be wielded frequently as the discussion addresses matters primarily of {social legitimacy} and {economic feasibility} — just as might be supposed for an engineer as author of this discussion. That of (T4), on quality in governance, epitomizes the use of both directional and wealth axes. That on ethics and equity (T5) supremely makes the case for the value of axes having to do with the wealth of thought. By the time we arrive at thread (T10) on “space”, the need to introduce any further, unfamiliar axes will have passed.

Yet we shall here no more miraculously extract simplicity from the jaws of irreducible complexity than was any singularity ever plucked from the jaws of plurality in Chapter 4.

(T1) *Personal Aspirations*

Looking inwards to the self, as the iconic stick figure in Figure B2.1, to what might you or I aspire: a need; a want; a luxury? Do these aspirations line up in a

(T1) Personal Aspirations	Health and hygiene
(T2) Citizen Participation	Individuals empowered to acquire and employ expertise and “know-how”; development of community skill base; taking responsibility
(T3) Social Bonds	“Cultural acceptance” — not bonding to group — as in adoption of a style of device or technology
(T4) Quality in Governance	Presence of an institutional-regulatory framework <i>per se</i> , irrespective of its deliberative quality
(T5) Ethics and Equity	
(T6) Valuation	Engineering economics (Total Annualized Economic Cost; TAEC); user/service fees/revenues; derivative attributes
(T7) Environment Within the Language of Business	Biodiversity
(T8) Supply-Value Chains	None beyond “factory (treatment plant) fence-line”
(T9) Commercial Sectors	Water ... alone
(T10) Space	IUWM or IWRM; rarely, if ever, both (and not including citizen agency)
(T11) Life Cycle and Time	Expenditures and revenue streams over time, with “set-asides” for technical R&D (innovation) and reserve funds
(T12) Function	Adaptability; durability; robustness-vulnerability; reliability
(T13) Gauging Environmental Benignity	Environmental degradation: pollution syndromes (issue domains) of LCA; impaired quality of outputs/emissions; eco-efficiency
(T14) Cycling of Materials	Man’s appropriation/consumption of resources (water, nutrients, energy, and land area); soil fertility

Table 1
Contemporary expression of the line items of Triple Bottom Line (TBL) accounting, as found in water-sector literature (*TBL_{now}*).

(T0) ORGANIZATIONAL LEARNING	“Always Learning, Never Getting It Right”; in pursuit of the self-transforming mind, which “leads to learn”; entertaining self-contradiction, including abandoning a TBL line item, even “sustainability” itself
(T1) Personal Aspirations	Towards a well-being sufficient for self-reflexive apprehension (grasp, appreciation) of the “big picture”; Engineers “Acting Most Locally” to engender a community eager to engage in “Thinking Globally”
(T2) Citizen Participation	Deliberative democracy
(T3) Social Bonds	Benefitting from multiple (four) wisdoms on how to live with one another and nature
(T4) Quality in Governance	Refurbished pluralist democracy of Dahl; clumsiness; adaptive community learning
(T5) Ethics and Equity	Variety of standpoints on the consequences of inappropriate behavior in man-to-man, man-to-nature, individual-to-group, present-to-future generation, seller-to-buyer, and other relationships
(T6) Valuation	Plurality of what counts, in which ways, to whom or what; bequests to the future (“final environmental wills and testaments”)
(T7) Environment Within the Language of Business	Natural capital, ecosystem services, and service providers, <i>ergo</i> loss of biodiversity as failure of ecosystem service providers; “New Scarcity” of resource economics
(T8) Supply-Value Chains	Exercise of power ever further along ever more extended and intricately interwoven chains of commercial relationships
(T9) Commercial Sectors	Water sector ... and nutrient and energy sectors ... and more ...
(T10) Space	From Earth Systems Analysis to individual agency (e.g., dietary preferences)
(T11) Life Cycle and Time	From cradle to cradle analysis
(T12) Function	Ecological resilience and (biomedical) self-repair
(T13) Gauging Environmental Benignity	Biomimicry: appetite; metabolism; pulse
(T14) Cycling of Materials	Natural nutrient cycles and technical nutrient cycles; eco-effectiveness; dematerialization

Table 2

Companion elements (of Table 1) in Triple Bottom Line (TBL) accounting that we can presently imagine as becoming candidates for application in the longer-term future (TBL_{future}).

sequence, to be picked off one after another? Are they arranged in a hierarchy, as so often are the (purported) “needs” of Maslow’s (1943) theory of human motivation in Wikipedia (accessed 18 April, 2010) and elsewhere?⁵⁴

Acknowledging the evident dominance of today’s hierarchical portrayal of Maslow’s ideas, this thread of personal aspirations works upwards from a tranche of deficiency needs — from basic physiological needs; up to safety needs; then love/belonging and social needs; thus to esteem needs — and on to a tranche of growth needs, comprising cognitive needs, aesthetic needs, self-actualization, and self-transcendence. Security of body, of “health and hygiene” (as in the *TBL_{now}* of Table 1), and of employment, are associated with safety needs, standing just above the profoundly basic physiological needs. Creativity, spontaneity, and problem-solving attach to self-transcendence, where this can be associated with notions of ascending towards becoming all that we are capable of becoming, at the apex of the hierarchy.

The discussion of Box 2, as well as that of Douglas *et al* (1998) in *Human Choice and Climate Change* (Rayner and Malone, 1998), suggests something otherwise, however: that ranking and labeling of aspirations, as “needs”, “wants”, or “luxuries”, change from time to time, from solidarity to solidarity, and place by place, as community debate ebbs and flows. The pyramid should be flattened, in effect. The supposedly self-evident axis of Maslow’s staged sequence of needs, with progress along it from the base to the apex of the (presumed) pyramid, would be pushed aside. Might thus there be similar flux in our individual, personal aspirations, which are the essence of the present guiding thread (T1)? On this account, the contents of both the *TBL_{now}* and *TBL_{future}* for this thread of personal aspirations might essentially be stochastic, continually undergoing a strategically unpredictable random walk across a level plain of aspirations and needs, up and down along the directional axis of Figure 16(b), as it were — the very opposite of what we might have expected to plot as an orderly sequence.

Yet some fundamental elements of existence seem stable and sequenced, along the following axis:

- unless (i) we avoid death, we cannot (ii) survive to suffer ill-health or enjoy good health, without which latter (iii) a sense of burgeoning well-being appears less likely.

There are traces of both direction and enrichment about such an axis. For it is generally better for people to be in the state of (iii), with direction in moving up the axis of Figure 16(b). A policy addressing issues of survival, treating ill-health, and exploiting good health (all three of (i), (ii), and (iii)) should strike one as richer in its scope — rightward along the axis of Figure 16(a) — than one addressing merely (ii) and (i), or another addressing, say, solely and exclusively (iii), towards the leftward pole (U) of Figure 16(a). A “wealth of analysis” may be graded as follows: acknowledging none of the elements of this existential thread (T1) — none of (i), (ii), or (iii) — will be labeled a 0-fold typology; any one of the three, as a 1-fold typology; any two a 2-fold; and all three as a 3-fold typology. Wealth of analysis grows as one moves from the 0-fold to the 3-fold typology, traversing successively the sequence of graduations left-to-right in Figure 16(a).

What is recognized of such things in the formation of policy?

Pragmatically, as engineers, we want something to happen in respect of sustainability. Our concern is to identify that policy or technological intervention of IUWM within IWRM that will pull the human condition away from unsustainability and on (we trust) towards sustainability, along the axis of this particular guiding “existential” thread. Where the state of affairs lies on the axes of Figure 16 clearly matters a very great deal. We might be especially interested in attaining that sense of personal well-being — the corresponding element of the *TBL_{future}* in Table 2 — which brings with it appreciation of the “big picture” (thinking globally) and the inclination to debate the good (or ill) of sustainability. And we might grade the attaching intervention as all the more sustainable for provoking such a self-reflexive — even self-contradictory — kind of disputation. This would be engineers “acting most locally” to engender “thinking globally” amongst a community (as already imagined in Box 2 of Chapter 3.1).

⁵⁴ The hierarchical interpretation could be said to be rampant. Any number of pyramid-like images of Maslow’s needs can be found by a Google search (accessed 18 April, 2010). Indeed, the Official Nebraska Government Website says “[a] person cannot move to a higher level until each preceding level is satisfied” (www.das.state.ne.us; accessed 18 April, 2010).

(T2) Citizen Participation

Looking outwards from the self, to what extent are you or I permitted or encouraged to engage with society, or barred or discouraged therefrom?

Shirley Arnstein's landmark paper on "A Ladder of Citizen Participation" was published in 1969 (Arnstein, 1969). Ascent of the ladder begins with manipulation and therapy, i.e., non-participation, through three degrees of tokenism — informing, consultation, placation — and up to partnership, delegated power, and eventually citizen control, with this second triplet of steps called degrees of citizen power. Her ladder seems an obvious candidate for a pair of axes in the space of our N -dimensional assessment of sustainability:

- participation of citizens in governance, graded according to the degree to which they do so

and

- the locus of power, whether balanced, or see-sawing and sliding back and forth (over the generations) between the pole (or province) of the citizen and that of the government.

In contemporary IUWM, citizen participation as such is manifest in a number of more or less similar ways in the corresponding line item of the TBL_{now} in Table 1. Stationed roughly midway at the level of partnership or delegated power on Arnstein's ladder, is where we might expect to place the acquisition of expertise and citizen "know-how" (as in Table 1): the end-user of a technology, such as a member of the public (a citizen, in fact), is presumed to know how to operate and maintain that device. The "development of a community skill base" (also in Table 1) could be perched on the same rung, as well as what Balkema *et al* (2002) call "sustainable behavior". In our interpretation, assuming a license to adjust the original use of these phrases, an employee or community is aware of technological and environmental endeavors. They participate in these endeavors; and they assume, therefore, the attaching responsibilities. They take responsibility, for example, for personal and community actions and for success or failure in the operation of devices owned and operated by that individual or community. They vote with the group in the public space of community debate, for a technological strategy of decentralization, say, of

Small is Beautiful (SiB) in Box 1. In their private space, they would accordingly turn off the bathroom shower before having any alarm alert them to the imminent profligacy of their consumption of water and energy (Willis *et al*, 2010).

Once the image of a ladder has been introduced (every bit as much as a pyramid), the natural impulse might be to applaud a policy or technology that seeks ultimately to bring citizen participation to the top of that ladder. For Arnstein this would be "citizen control". Yet from there one can barely banish the further image of a toppling off the ladder into some kind of anarchy. In contrast, towards the bottom-most rungs on the ladder, the tokenism of informing, consulting, and placating smacks of government planning authorities checking boxes in some prescriptive procedure intended yet to keep *their* authority dominant in the community power structure. From Boulanger's (2008) perspective, inviting citizens to endorse a decision already made (the readily recognized lowest form of tokenism) would be a manifestation of the workings of a democracy inferior even to his aggregative model thereof. In sharp contrast, we should enter his (and Dahl's) "deliberative democracy" into the TBL_{future} of Table 2.

Viewed from another angle, the line of Arnstein's ladder might bring to mind the vertical axis of Figure 3, running between the egalitarian spirit of symmetrical transactions and the asymmetrical transactions of the hierarchy. Arnstein was concerned with the relationship between government and the individual. The continuum of participation along this (T2), and the attaching notion of power in this government-citizen relationship, is not the same as the symmetry-asymmetry of transactions of Cultural Theory in Figure 3 (and eventually (T3) below). Hierarchies, in the upper right quadrant of Figure 3, institute status differences, with their asymmetrical transactions. Of society in Boston, USA, it has famously been said that "Lowells speak only to Cabots, and Cabots speak only to God". That, then, is the kind of asymmetrical social transaction that egalitarians, with their passion for "symmetry", would abhor.

Being engaged with society, and the extent to which citizen participation is achieved, in the sense of Arnstein's ladder, is thus different from an individual belonging to a like-minded group (or solidarity). The like-mindedness is about signing up to the tenets that

make the solidarity what it is: egalitarian, hierarchist, and so on. The two pairs of axes — participation and power (here, (T2)); transaction and competition in the ways solidarities form (there, in Figure 3) — are out of alignment.

(T3) Social Bonds

Still looking outwards from the self, how monolithic or endlessly variegated and differentiated is our perception of Society “out there”? Are there any groupings? In how many ways do these groupings organize and bind themselves into solidarities? And to which such grouping might I choose to belong, because there lies the greatest empathy between my perception of the world — in particular, on the Man-Environment relationship — and the solidarity’s collective perception?⁵⁵

Along this thread, considerations may be as rudimentary as grading the (technological, environmental) performance of an entity as though society does indeed exist — somewhere vaguely “out there” — and is somehow pertinent (our cynical engineer’s jibe at engineering for sustainable development). It is acknowledged merely that technical, economic, and environmental performance may not be the only, or the primary, grounds for adopting a technology or policy, but little more. Society is relevant to the assessment, but largely by default, as it were: an impoverished 0th-order, or 0-fold typology — or non-recognition, in other words — of the various ways people organize and bind themselves into groups and then act within that society. If the axis of Figure 16(a) were to stand for depth and subtlety in the appreciation of “social bonds”, then under such superficial treatment we should be grounded at its leftward pole, i.e., (U).

Moving towards the other end of Figure 16(a), assessment may distinguish between “markets” and “hierarchies”, which in their turn constitute just two of the yet further differentiated four solidarities of Cultural Theory. Given the axes in Figure 3, of

- transactions, gauged between the poles of symmetrical and asymmetrical

and

- competition, ranging between unfettered and fettered

subtlety and complexity (wealth of thought/assessment) can be judged to be increasing as one passes the successive graduations (in Figure 16(a)) of 0-, 1-, 2-, ... n -fold (and so on) ways individuals may organize themselves into groups and differentiate themselves from each other. By adding in such subtlety and complexity of the n -fold typology, we should have traversed the axis and provinces of Figure 16(a) to occupy the refinement of boundary (R).

Detached in the present discussion from any specific solidarity, these axes of transaction and competition should not be understood as “directional” (according to Figure 16(b)). To hold a (directional) preference for fettered over unfettered competition is to be committed already to a hierarchist (H) or egalitarian (E) solidarity, as opposed to the individualist (I) or fatalist (F) camps. Similar kinds of attachments are implied in preferring asymmetrical over symmetrical transactions. Wealth of analysis here (according to Figure 16(a)) is about how many solidarities (actors, voices) are recognized, not any preferences — *ergo* a sense of “direction” — of being committed to any one of them. This wealth grows as one recognizes and accounts for, say: first solely I (as in markets); then I and H (markets and hierarchies); then I , H , and E ; and finally I , H , E and F . The graduations in turn mark four intervals (domains) along the generic wealth axis of Figure 16(b).⁵⁶

Armed with this understanding of a 4-fold set of social solidarities and their interactions, an assessment of the sustainability of a policy, decision, or technology will be less or more fully attuned to the rich heterogeneity of implications and consequences of each of the plural solidarities’ aspirations for the future. And better more so than less so, we submit, in respect of {social legitimacy}, with thus now indeed a hint of some (arrowed) direction of quality in policy formation. The mesh of the social assessment would be finer with all four solidarities acknowledged, than with the coarse

⁵⁵ In fact, how do I relate to you (as another individual)? Fiske and Haslam (2005) maintain there are but four ways: a four-fold typology, but not one (and this we should welcome) necessarily mapping over that of Cultural Theory and Figure 3.

⁵⁶ The four quadrants of Figure 3 were constructed according to the axes of “transactions” and “competition”. In that respect these two axes provide a basic and unchanging way of thinking about the nature of social bonds. Here, however, wealth of analysis is plotted according to how many of the so-constructed and thus revealed solidarities are taken into account in the given policy assessment.

mesh of not recognizing the way any groups organize and express themselves in a society.

We have written frequently of *Cultural Theory*. Table 1 has an entry for *cultural acceptance*. But the adjective (cultural) is not being used identically in the two phrases. Each household in a community may adopt a quite different stance on whether it will give house space to a new piece of plumbing, such as the urine-separating toilet, hence the phrase “cultural acceptance” in Table 1 in association with the *TBL_{now}*. In Europe acceptance may be high (Lienert and Larsen, 2009), while elsewhere, in Inner Mongolia, it is known that the installation of similar devices has suffered from a lack of cultural acceptance (Yu, 2010). More dramatically — as the 2010 Haiti earthquake (and others before it) has revealed — even in the most dire of circumstances, individuals will not seek to protect themselves from the elements in the “house space” of technically well-performing emergency shelters, if their designs are not *culturally attuned*. No matter how basic and desperate might be the need of shelter from the storm (viewed from our perspective), some other want, or need, or personal aspiration (within (T1)), over-rides it.

Less dramatically, yet important nonetheless, there is something essentially different and unique about the cultural dimension of water, relative to that of energy, including in respect of re-engineering city infrastructure. Except possibly and rarely in its manifestation as fire, energy does not seem to play such a fundamental role as water in our massively diverse spiritual cultures. As Davis (2008) puts it:

No substance in the world is endowed with more cultural and religious significance than water.

No substance in the world has deeper emotional resonance or aesthetic appeal than water.

No-one would argue this might not be profoundly significant for re-engineering the infrastructure of a city and re-balancing the city’s interaction with its aquatic environment. This meaning of the word (culture) is hugely important for engineers with their proposed and preferred devices and technologies. People care about how they interact with their water infrastructure and environment in ways absent

from their interaction with an energy or transport infrastructure, for example.

“*Culture*” in these senses — and in that of the entry for “cultural acceptance” in Table 1 — assumes a meaning somewhat different from the “ways people bind themselves into groups” (as in Figure 3).

The labyrinthine complexity of society may seem overwhelming to the water professional in its supposedly endless variegation and differentiation. Cultural Theory and Figure 3, however, tell us that there are four, and only four, ways of organizing (and disorganizing) — omitting, that is, the autonomous existence of the archetypal hermit (at the origin of Figure 3; Thompson, 2008a). Things are neither as simple as the customary dichotomy of merely “markets” (the individualist style of organizing) or “government regulation” (the hierarchist style of organizing), or Arnstein’s focus on “citizens” and “government”. Nor are they as complex as being infinitely variegated and differentiated, with each individual having *his* or *her* personal construction of the way the world is (and its attaching science). The corresponding axis of wealth and enrichment of Figure 16(a) is bounded at *both* ends, at (U) *and* (R).

While surely *no* theory can explain everything, Cultural Theory appears less flawed (for the time being) than any other framework acknowledging fewer than its four ways of associating within society. Besides, to take advantage of just one or two sets of experience and wisdom on how to live with one another and with Nature is to risk being impoverished and coming up with less unsustainable policies, designs, products and technologies. For this reason, the corresponding entry for (T3) of the *TBL_{future}* in Table 2 seeks recognition of a fourfold set of wisdoms.

Yet the indeterminacy brought about by there not being simply a dichotomy, entails the life-like, complex dynamics of interactions amongst the four solidarities, which may lead things in sometimes destructive and sometimes constructive directions (Thompson,

2008b; also Gyawali (2004) and Box 4).⁵⁷ This, while it may be frustratingly unpredictable, is not utterly incomprehensible. There are rules that seem to work. What is more, they can be rooted in the physics of stability-instability in the dynamics of nonlinear systems.⁵⁸

(T4) Quality in Governance

In his book *Resolving Messy Policy Problems: Handling Conflict in Environmental, Transport, Ageing and Health Policy*, Ney (2009) has argued thus:

Over the past three or four decades, the institutional settings of policy-making have changed as rapidly and profoundly as have our society. In the not too distant past, policy was something produced and owned by ‘government’. Working within recognizable institutions, governments steered societies by making and enforcing rules. Today we use the far more amorphous term ‘governance’ to describe a confusing myriad of criss-crossing activities, institutions and processes that all seem, in some way or other to contribute to similarly opaque things called ‘policies’.

Widening and deepening the remit of policy-making has meant that governance involves more, and a rather different mix of, people than did government.

By widening the scope of policy actors and weakening the hierarchical control of central governments, the differentiated polity creates the potential for intractable policy controversy.

German political commentators have called this Reformstau — a backlog or congestion

⁵⁷ If surprising failure (such as a global economic crisis) brings about the need to organize and manage affairs differently, the twofold typology is entirely predictable: unfettered markets will be abandoned in favor of strict regulation — individualist style (*I*) is shed for that of the hierarchist (*H*) — and *vice versa* (*H* for *I*). With four ways of organizing and disorganizing, it is not likewise determined how an *I* style of managing might in the event be obliged to reorganize as hierarchist, egalitarian, or fatalist instead, and so on (and on).

⁵⁸ This, I readily confess as an engineer, has been the supreme achievement of Cultural Theory for me personally. I have tried to resist its appeal on many occasions, but to little or no avail. As a result, Table 2 is replete with entries for the *TBL_{future}* that reflect an underlying and pervasive plurality of perspective in addressing matters of stewarding the Man-Environment relationship.

of urgent reforms necessary to revitalize our societies.

Our interest here is not in “Reformstau”, even if it were the destructive kind of impasse of concern to Gyawali (2004) (and to our discussion of Box 4). It is rather in the refurbishment of Dahl’s pluralist democracy, which Ney (2009) has proposed as a means of unblocking the policy logjam. Above all, Ney’s scheme provides us with yet another elementary, irreducible guiding thread: of *deliberative quality* in governance, i.e., (T4). In turn, thread (T4) is conditioned on the ways of organizing recognized in the preceding thread (T3) of social groupings. Yet this deliberative quality is not the thread of participation of (T2).

Here now is where the generic forms of both axes of Figure 16 assume specific and substantial import. Access and responsiveness are the two guiding axes, above which the surface of deliberative quality rises. We define three axes, therefore, the first pair having to do with wealth of assessment (as in Figure 16(a)):

- access to the debate, ranging from one to several given voices-actors (which in its turn is still *not* the same as Arnstein’s “participation”)
- responsiveness, by none, or one, or two, or several of the other voices, to the say-so of the given voice-actor (which was the organizational goal in staging the IWA Sustainability *Agora* of Box 4)

and the third being associated with direction (Figure 16(b)), i.e.,

- quality of deliberation itself.

A surface can be plotted in this specific three-dimensional space in Figure 17. It has two axes on the horizontal plane of wealth of assessment, with arrowheads for neither, and the third rising vertically, with an arrowhead.

Dahl’s classic theory gives us an over-simple and dualistic scheme: *closed hegemony*, when there is neither access nor responsiveness; or *pluralist democracy*, when both obtain. This is pictured in the inset of Figure 17. No third axis is needed on this two-dimensional plane. Under this coarse mesh of thought, betterment is associated simply with moving out of the box of closed hegemony and into that of pluralist democracy.

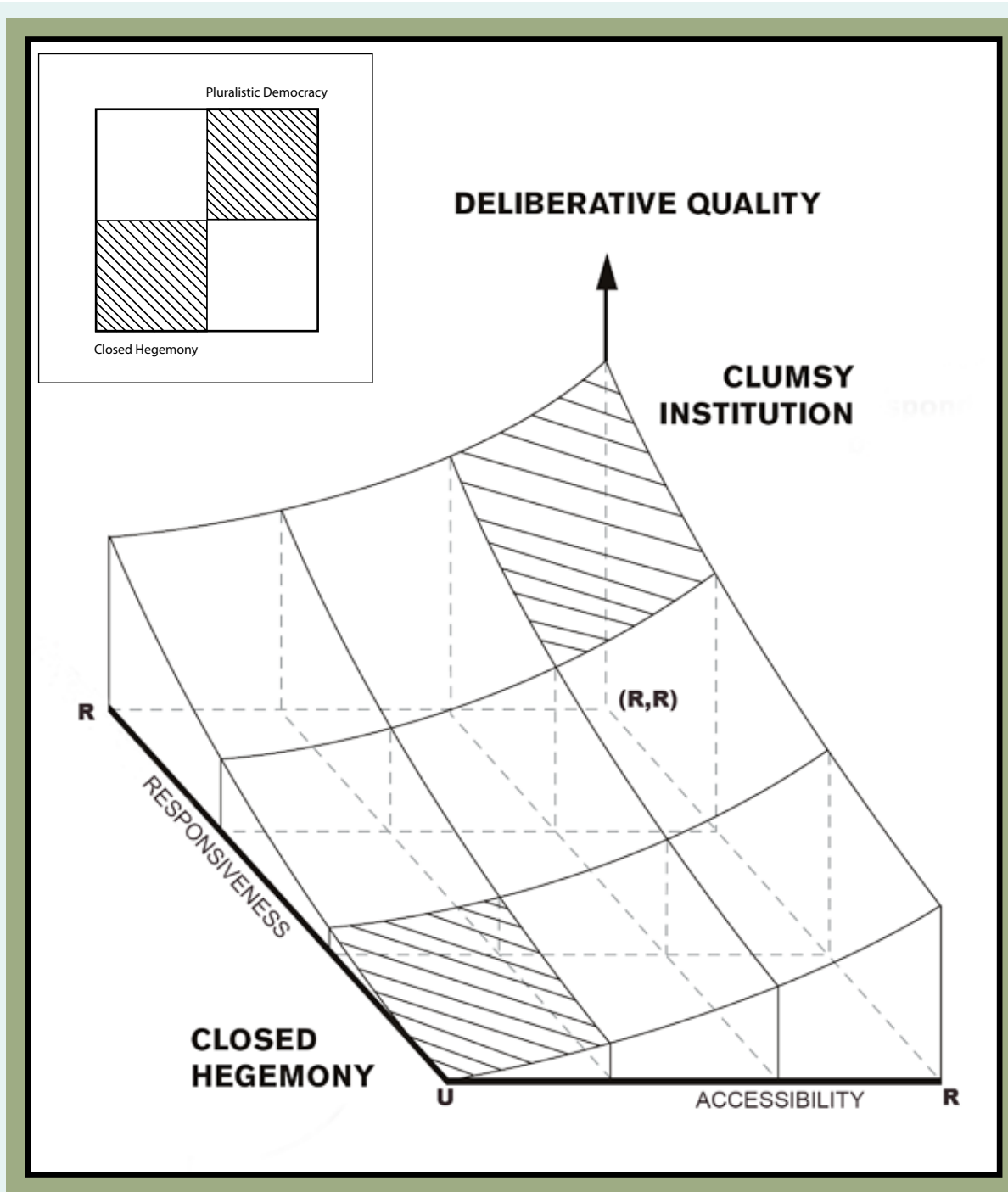


Figure 17
 3-D space of assessment for (T4) "Quality in Governance". Axes of accessibility and responsiveness bear no arrowhead and gauge accordingly wealth of assessment. The axis of deliberative quality, in contrast, is directional. The domains (provinces) of "closed hegemony" and "clumsy institution" are shown cross-hatched. Inset: the 2-D matrix of Dahl, showing the companion "closed hegemony" and "pluralist democracy". In effect, the inset is a (past) "bare-bones" assessment of governance, whereas the complete (contemporary) 3-D space has "fleshed out" — refurbished — that earlier conception of what amounts to good governance, as gauged by deliberative quality therein (adapted from Thompson, 2008a).

Refurbished by way of the typology of Cultural Theory — *enriched*, that is — we are able with a finer mesh of thought to map an extensive “excluded middle” (Ney, 2009). Each graduation along the two axes of accessibility and responsiveness in Figure 17 marks thus the addition of another voice to the debate, be this hierarchist, individualist, or egalitarian, in any order. In the generic sense of Figure 16(a), affairs are progressively becoming more subtle, richer, and more complex, as one moves away from the origin (U) along either axis. As the eye travels along the axis of responsiveness (in Figure 17), more voices are seen to be responding to the debate, although some may have no access to it. Plotted thus on Figure 17, closed hegemony grants access-responsiveness to just a single voice, while the inelegant but exemplary clumsy institution is the refurbished form of Dahl’s original pluralist democracy. The former has a vanishingly small deliberative quality — on the third, directional axis of Figure 17 — while the clumsy institution has scope for attaining the highest of such quality. It grants access-responsiveness to all three of the active solidarities; thus it lies at point (R,R) above the two-dimensional plane of access and responsiveness. Most policy sub-systems fall somewhere between the two.

In the worst place of closed hegemony, the one actor granted access (agency; institution; solidarity) will choose to frame the problem such that it may be solved by that actor’s favored style of problem-solving and governance. Under this lowliest quality of governance, just as the International Water Association’s *Sanitation 21* document complains (IWA, 2006; see also Box 2),

[O]pportunities for exploring the whole range of potential solutions may be lost and the agenda may be ‘hijacked’ by one particular interest group ...

... perhaps an engineer with highly technical knowledge, or perhaps someone from a development agency with a strong social agenda or a strong home-industry export agenda, or again it may be the environment agency or a donor with a strong commitment to environmental protection.

In other forums, such as the IPCC (according to Pielke, 2010), the hierarchical voice alone has framed the debate, while the voice of the so-called voodoo-science solidarity has been denied access and merits no reasoned response from within the (closed) debate,

hence the dismissive jibe. A form of power — to recall this axis from the relationship between citizen and government of (T2) — is here being exercised through the matrix of access-responsiveness. This too would have been the situation in respect of the South Asian experience of flood management, as related in Box 4 of Chapter 4.2 (Gyawali, 2004). All are redolent of the tokenism of *government* behavior, towards the bottom-most rungs on Arnstein’s ladder, with the government agency being the only voice granted access to the closed hegemony of Figure 17, hence its lowest quality of *governance*. Thus can we appreciate better the changes in phrasing between Arnstein’s and Ney’s times — between “government” (Arnstein, 1969) and government as a player within a system of “governance” (Ney, 2009; see also Termeer, 2009).

The clumsy institution, so the normative argument runs, is where we should strive to be. We should incorporate it into the scaffolding for a TBL_{future} of Table 2. The relative richness of the nine “provinces” on the surface of Figure 17 should allow us to discern where our given, problem-tailored, policy subsystem presently lies, thus to identify the various pathways by which we can move closer to where we want to be (Ney, 2009) — progressing step by step along and up the axis of deliberative quality. The foregoing advocacy in Chapter 4 of an experimental and adaptive structure of governance might be just such an enabling device, in particular, on an urban scale. Cultural Theory does not guarantee the benefits of a clumsy solution. Nevertheless, if institutional arrangements are as in this uppermost province (in Figure 17), and there exists the possibility of a clumsy solution, then it ought to be discoverable with greater probability than would have been the case, had those institutional arrangements remained “suavely elegant” (with thus lesser deliberative quality). In particular, we might ask, what engineering intervention or technological innovation of CFG, IUWM, or IWRM, might project the quality of governance upwards?

The TBL_{now} of Table 1 acknowledges the significance of the “institutional-regulatory framework”, but is otherwise silent on the quality of the deliberations it may deliver.

In its own small way, Figure 17, with its three axes, is essentially a 3-dimensional sub-space (or microcosm) of the N -dimensional framework by which we are seeking here to extrapolate from the TBL_{now} (from

Table 1) and within which we wish to erect the scaffolding for constructing some form of *TBL_{future}* (within Table 2). Beyond the abstractions of Figure 16, it is the specific, graphical epitome of our central purpose in this chapter on change. Figure 17 may not be quantitative, but its intent is clear. The key to insight and progress is not merely the definition of the axes, but also the separate graduations along them, hence revelation of the middle provinces interpolated between the bare bones of Dahl's original dualism. A step has been taken, from a sparse, original dualism, to something markedly *enriched*. We have moved along the axes of our logic from an ignorance, or non-recognition of something of import in assessing what sustainability amounts to (at worst, a 0-fold typology, for example), to the richness — and greater difficulty of grappling with (and judging according to) — a higher, *n*-fold typology.

(T5) *Ethics and Equity*

What do I owe to myself, or to any other entity, or that entity to me? What does any social grouping owe to any other entity? How should affairs be conducted, in respect of these relationships between the self and the self, the self and another individual, the self and the group, and any other entity? For such conduct may be good or bad, fair or unfair, noble or ignoble, right or wrong, just, dishonorable, virtuous, and so on. In fact, with how many other fundamentally different types of entity can the self/group have a relationship? For there can be superiors, peers, and subordinates (“inferiors”); competitors, collaborators, and neutral referees (or disinterested bystanders with whom there is little or no relationship); suppliers along a supply chain; all manner of associations and institutions in a policy-subsystem of governance; there can be mankind and a multitude of other species of organisms; and there can be past, present and future generations of man and beast alike.

What mesh of axes, orthogonal or not, might now chart the differing sub-domains and provinces across such considerations of ethics and equity? What space might be constructed to do for them what Figure 17 has done for the quality of democratic deliberation?

We cut a candidate path of logic amongst all the entities sprayed about like blunder-bus shot in the preceding paragraph, to suggest at least these four axes:

- the number of individuals, essentially distinguishing between the one (*ergo* the individual) and the more-than-one, i.e., the group
- financial status, i.e., the categories of non-monetary or monetary, which latter will include the distinction between buyer (customer) and seller (service provider)
- species, cleaved crudely into the pair of human and non-human, but recognizing a continuum of species spanning in theory from the blue whale across to the chemical species of minerals and inanimate rocks
- generations (time), as in the trichotomy of past, present, and future — and the different graduations according to whether one, two, or three of these generations are being entered into the assessment of sustainability

All of our threads ((T1) through (T14)) are cardinal with regard to sustainability. This on ethics (T5), however, must be granted special status. It is privileged. Its role is born of that most basic instinct: the dawning in the mind that one owes something — and something about the well-being of the Environment — to the future; and that, in particular, one owes this something to one's offspring. This last of the above four axes cuts through the heart of sustainability as it looks ahead to future generations. And the behavior of the present generation relative to that of past generations reveals much of the significance of the glorious diversity of culture in thinking about sustainability (along thread (T3)).

At one corner of what would need to be at least a 4-dimensional sub-space corresponding to Figure 17, might therefore reside the self, as if nothing else in the world mattered. At this pole of the intersection of the leftward boundaries of the four wealth axes (from Figure 16(a)), rather like the province of closed hegemony in Figure 17, the frame of ethical assessment could be said simply to be unrefined, empty, vacant, or undeclared (U) — the very coarsest of unrefined meshes of thought.

Proceeding away from this most rudimentary basis, provinces of ever greater richness, subtlety, and complexity of considerations can progressively be stacked up (just as they are as one moves away from closed hegemony in Figure 17): by the introduction of

another individual to whom one relates; to which can be added the refinement of distinguishing between the monetary and non-monetary status of that relationship; and then that of a group, as opposed to an individual (and groups to groups); then human and non-human; future human generation(s); future non-human generation(s); and past generations; and perhaps on and on and on, as far from corner (U) as the mind can conceive of. What is more, such extrapolation has not even begun to acknowledge a fifth axis of:

- ethical schemes, distinguished as motivational, behavioral, consequential, and more (Harremoës, 2002) and colored and shaded by the outlook adopted on caring (or not) for the consequences of action (Thompson, 2011)⁵⁹.

Remote now from the ignorance and coarseness of (U), we find subtlety, complexity, richness, and refinement (R) in gridding the frame of ethical assessment of any policy for CFG, or for IUWM within IWRM.

You or I might have voted with the group in the public space of community debate for the frugality and eco-efficiency of a decentralized, Small-is-Beautiful (SiB) policy. Yet in our individual private spaces of the bathroom shower, the alarm is blithely ignored as it flashes transgression into profligacy. There is a not-unfamiliar whiff of double (ethical) standards about this. The policy might be deemed wholly unsustainable — without ethics — on any and all accounts under (U), quite otherwise under (R). Or, according to (U), it might have seemed ethical and sustainable in principle in the public space, merely unrealizable and practically ineffective in the private space. Whatever the judgment, the policy is the same. It is just that the framing of the assessment has changed: blank and vacant for (U); finely and richly gridded and replete with axes and provinces for (R). It is as the difference between just the two provinces of Dahl's original notion of plural democracy in Figure 17 and the nine of Ney's refurbishment of the theory.

With considerations in Table 1 largely confined to those of entities such as engineered facilities for wastewater treatment in IUWM, an entry corresponding to this

⁵⁹ Significantly for this *Concepts Paper*, Thompson's article is entitled "Material Flows and Moral Positions". It deals with two case studies, one of which has to do with community decision-making in the matter of renewing (or demolishing) housing stock in London.

thread (T5) is conspicuous by its absence from the *TBL_{now}*. This does not mean that those, after whose contributions the contemporary consensus of Table 1 has been fashioned, thought nothing of ethics and equity. Rather, these matters would have been so obviously the motivation for sustainability in the first place, that they may well have been taken for granted — presumed, without any further debate (as we shall shortly see).

In contrast, the entry for this line item in the *TBL_{future}* of Table 2 anticipates the immense richness of thought caught in the highly refined mesh-like gridding of (R) (relative to the emptiness of (U)). Assessment would become dauntingly explicit in thinking about the multiplicity of ethical frames applicable to a host of all manner of relationships as though ethics and equity obey some inner, fractal, self-similarity with sustainability in *toto*. We *ought* to value many more of the entities in the world than merely the self. Increasing the collective wealth of awareness, along all of the axes (of Figure 16(a)) introduced for the current thread (T5) (of ethics and equity), has here a sense of a desired direction (up the axis of Figure 16(b)).

What is entered for (T5) into Table 2 is spurred no less by what we shall eventually see of (T5) in the *TBL_{frontier}* of Table 3 (in Chapter 6).

(T6) Valuation

Traveling along one axis of (T5) in particular brings a certain clarity and immediacy of purpose to the foregoing discussion of ethics. It is that of the financial status of things. The instrument of the market places a price on entities, hence the axis of

- competition, as already drawn in Figure 3 (and therefore (T3)).

Its continuum ranges from one extreme — the utterly unfettered market (the way of organizing of the individualist solidarity) — over the commonplace of less or more fettering through government subsidies, taxes, and "cap and trade" policies, to the other extreme of an entirely regulated market (the way of organizing of the hierarchist solidarity). Figure 3 simply acknowledges just the two broad sub-divisions of this axis, into the provinces of fettered and unfettered.

To this axis of competition can be added that of

- species, as for (T5).

Now, however, when it comes to monetary matters, it is the cut between humans and all else that is so profoundly important. Attempting thereafter to value the “all else” has provoked the emergence of environmental, ecological, and other schools of economic thought, together with so very much debate.

Thinking in a third direction, of discounting costs and benefits over time, and the no less disputed choice of its rate in the Stern Report (Stern, 2006; Godard, 2008; Lasry and Fessler, 2008), the axis of

- generations

comes back to mind, with the same scope for graduations, categories, and provinces as previously in (T5).

Towards the most rudimentary corner of this 3-dimensional space (symbolically, point (U)) lies the engineering economics (V_0) of Chapter 3.2: calculation of the construction and operating costs of a wastewater treatment plant for choosing amongst several alternative designs or upgrades (Jiang *et al*, 2005); fettered to the extent of needing to meet a regulation for environmental protection; metering within the facility fence-line the costs of electricity, process chemicals, labor, and so on — but leaving ecosystem services un-metered and therefore not evaluated; and discounting the sunk construction costs over the life-span of the facility (not the spans of human or non-human generations). Such things comprise the corresponding entry for the current thread (T6) of the TBL_{now} in Table 1. There, the “derivative attributes” (Table 1) of these expenditures of engineering economics would be expressed (according to Balkema *et al*, 2002) as cost-effectiveness, labor, and affordability. Thus are considerations of ethics and equity channeled indirectly into Table 1, through the lens of the affordability of a utility’s services to its customers.⁶⁰

According to our caricatured account in Chapter 3.2 of the economics of valuing the presence of oysters in Chesapeake Bay, V_E adds in the “value to the present human population of knowing the oysters are there in the bay and knowing too that future generations will likewise appreciate this knowledge” (from the

⁶⁰ Affordability is a prominent consideration in the principal messages emerging from the 2009 UN World Water Development Report (WWAP, 2009a,b).

perspective of environmental economics). This is over and above what is valued in the purviews of V_0 and V_C , i.e., the “conventional” economic valuations. V_E would seem accordingly to lie somewhat further away from the most rudimentary province of the generations axis of (here) our 3-dimensional sub-space for valuation. It addresses more directly not one, but two segments of human generations (present, future). Moreover, since it expressly recognizes the value of the oysters in the environment, as opposed to their consumption in a dockside restaurant, it notches up something additional along the species axis (in comparison with V_C).

Relative to V_E , valuation V_X from the perspective of ecological economics should appear as more distanced yet from the leftward boundary of this same axis of species (its coarsest mesh of assessment). For it takes further into account “the value of the services of the oysters in filtering, and thereby cleansing, the bay’s waters to the benefit of *their* (the oysters’) ecosystem” (Chapter 3.2).

It is *not* that distance from corner (U) in this space for Valuation (T6) gauges the attribute of “more/less ethical” from (T5), but that considerations of policy sustainability become ever more enriched, as one successively recognizes the legitimacy of, say, first solely V_X , then the pair of V_X and V_0 , then the trio of V_X , V_0 , and V_E , and so on — going from a single-fold to an n -fold typology, including the n ethical schemas behind the various kinds of valuation. Sustainability is about valuing a greater number of entities in the world. This thread (T6) of valuation relates back, therefore, to that of ethics (T5) and looks forward to the language of business in the next thread (T7).

No-one has ever said things would get simpler. We may crave this. The notion of some succinct operational definition of sustainability might extend the tempting illusion of such simplicity. But it is an illusion, nonetheless.

(T7) *Environment Within the Language of Business*

(T7) is manifest along a continuum of increasing subtlety and depth in the penetration of business thinking: from natural capital, through ecosystem services and service providers, and on to considerations of biodiversity. Indeed, on inspection of the entries in Tables 1 and 2 for this thread, we may be tempted to

conclude that here we have a certain maturity: TBL_{now} approximately equals TBL_{future} .

Gauging “environment within the language of business” entails its own unique logic, with increasing depth and subtlety. First, there are “stocks” of capital. Second, we may choose to assess them in one or more forms, such as, for example, human, financial, manufactured, and natural. Third, natural capital may be differentiated into a number of environments: atmosphere, lithosphere, hydrosphere, and biosphere; and then into species — of the strictly *non*-human category; which species, fourth, are responsible for flows of services of benefit to mankind; integral to which, fifth, is biodiversity; and, sixth, the risk therefore of the extinction of species (over time), perceived as a threat to business — or “business-as-usual”, that is.

Of interest furthermore are matters of exchanges and transfers amongst the forms of capital — fungibility (in the language of economics) — and between human generations, as in Solow’s concept of bequests to the future, suffused with its moral and ethical dimensions, which returns our argument (again) to the thread of ethics and equity in (T5).

The key to the role of (T7) is not that it calls for any new axis, but that it is right for our times (for a few years, at least). It transforms into the contemporary idiom what was expressed in the less enriched language of four decades ago when Meadows *et al* (1972) wrote of the *Limits to Growth*. Theirs was the language of “resource depletion” and “pollution control”. Thread (T7) extends the notion of {economic feasibility} away from the engineering economics of V_0 and embraces valuation of many more of the entities classified and addressed as matters of ethics and equity in (T5). It gives us, furthermore, a positive spin on what previously had a negative spin to them: it speaks of “things we should do”, as opposed to “things we should *not* do”. The obligation of Brundtland’s definition of sustainability is to build (positively) all forms of capital, but especially natural capital. It is not as confining as was once the urging: not to deplete resources and not to pollute.

(T8) *Supply-Value Chains*

Business entities, such as water utilities (private or public), sit within an arc of flowing goods and services. They have suppliers and customers. They can apply their ethical systems of sustainability backwards to other business entities along the supply chain/

trajectory, and ever further so. Thus do such entities acknowledge risks to the violation of human rights, as in risks to those rights along the supply chain and amongst the most vulnerable customers, as embodied in the UN Global Compact (UN Global Compact, 2008; www.unglobalcompact.org; accessed 24 November, 2010). Where there is a buyer and a seller, i.e., a financial transaction, so there can power be exercised in that relationship (for good or ill) — purchasing power, or consumer power.

Where there is political power, or patronage, as in the mayor who champions (or not) pursuit of the sustainable city, so may the shots be called over the construction company hired to excavate trenches in the street. In the light of such power, the form of the trench and the mode of its excavation and filling may (or may not) be more or less sustainable. Context and place matter. The construction company (the seller) may be deemed sustainable in city S, led by its enlightened mayor (the buyer), and yet unsustainable in its behavior in city Y, which lacks a mayor with such enlightenment and for whom any old trench might suffice (sustainable or otherwise). Should a sustainability-driven asset manager judge that construction company to be therefore sustainable and worthy of its investment, or not? For like the curate’s egg, it is good in some places, poor in others. A manufacturer purveying the latest technologies for desalination might be deemed sustainable in today’s terms, for facilitating the access of more poverty-stricken people to wholesome, life-sustaining, potable water, but unsustainable in respect of exposing many more of the next generation to flooding from sea-level rise and increasing hurricane activity (as conjectured in Chapter 2.2). Place *and* the long view matter too.

Power is exercised across the levels in a hierarchical institution, of course. The supply chain is itself a form of hierarchy. Yet this is neither the same as, nor all that defines, the hierarchist outlook on the Man-Environment relationship, where predictability of outcome and the redemption of mankind from its erring ways are sought (under thread (T3)). The Cabots of Boston are not the buyers of anything the Lowells might have to sell; there is no monetary transaction defining their relationship one to another in the hierarchist solidarity of Cultural Theory. Just as it should, therefore, this current thread (T8) encapsulates something of relevance to assessing sustainability that

neither (T3) on social groupings does, nor (T2) on citizen participation.

Two axes chart the extent by which (T8) is gauged:

- the length of the arc of the supply-value chain, or the number of enterprises within it

and

- the manifestation of power along each link of the chain, segmented into provinces, for example, of apolitical/political, legal/illegal, monetary/non-monetary

A minimalist stance, towards the coarse-mesh corner (U) of the two-dimensional chart (like the inset in Figure 17), would acknowledge no chain. There would be but a single entity enclosed within the “fence-line” of the industry, or wastewater treatment plant, free of any acknowledged obligation to any other service provider or consumer. In the absence of any relationship, power seems irrelevant.

Moving away from (U), entity after entity can be added to the chain. Power can be categorized progressively as single-fold, if it is recognized as present; then two-fold, distinguishing most obviously between monetary and non-monetary (as previously in (T2)); and so on, separating out further the forms of “non-monetary” power — segment after segment, along the generic axis of Figure 16(a), or within the specific, figurative context of Figure 17.

Far from the leftward boundary (U) of the axis for length-of-the-arc, the province of a supply-value *circle* can be imagined (at (R)) — and just as much the deliberate breaking of that circle. The individual employee of the tail-of-chain business, or perhaps that entire business, may elect not to purchase any product or service from the head-of-chain entity. S/he (it) would be exercising consumer power, along the companion (orthogonol) axis.

The outlook of the corresponding entry for the TBL_{now} in Table 1 extends no further than the factory (treatment plant) fence-line. That of the TBL_{future} in Table 2 spirals ever outwards, from IUWM to IWRM and beyond.

(T9) Commercial Sectors

The logical thread of supply-value chains in (T8) is dominated by its axis gauging the length of the arc of enterprises and business entities, now qualified (notably) as within the chain of *solely* the water sector. It is applicable here also, with no further modification or embellishment.

A glance back at Figure 1 — and all the ensuing dogged argument in favor of projecting the image of an urban *nutrient* infrastructure into a conventionally *water*-centric outlook — brings to mind a second axis for the present (T9):

- the number of economic-commercial sectors.

From our entirely appropriate origin in the water sector — the lone entry in the TBL_{now} of Table 1 — sub-divisions and provinces fan out along this second axis, as further sectors are successively brought into considerations of what constitutes sustainability in the water sector, or what it might take to realize the notion of a city as a force for good. Like the graduations on the axes of Figure 17 or Figure 16(a), the different domains might best be defined by the number of sectors addressed *jointly*: first, and most rudimentarily, just the one (water); then two (water and waste-handling, say);⁶¹ then three (water, waste-handling, and food); and so on, towards some remote province of a very high-order multi-sectoral analysis.

The analysis of Villarroel Walker (2010) for assessing eco-efficiency and eco-effectiveness in our Atlanta-Chattahoochee case study is a five-fold affair; it accounts for the interactions amongst the water, waste-handling, food, energy, and forestry sectors. Villarroel Walker’s original analysis, however, is anything but one of the flows of money along the supply-value chains within (and amongst) these sectors.

Surveying the shape and extent of this ninth logical thread (T9) in the fabric of a candidate TBL_{future} calls for a third axis, of

⁶¹ It is telling how words fail us: there is no “nutrients” sector as such; the best that could be done hitherto has been to use the phrase “waste-handling” (Villarroel Walker, 2010).

- “materials”, such as carbon, nitrogen, phosphorus, water, energy — *and* money.⁶²

Some of the greatest opportunities for progress towards sustainability and the CFG doubtless lie at the interfaces amongst the customary delineations of single strands of infrastructure (Beck *et al*, 2010b; Villarroel Walker and Beck, 2011a). The promise of a single, potentially innovative technology — originating, for example, in membrane science or biotechnology — cannot be properly assessed, if abstracted and considered in isolation (as it usually is) from the complex web of technologies of which the whole of the city’s infrastructure is composed. An innovation in the food sector, say, may have significant consequences for innovations in the water and energy sectors. An innovation timed correctly (incorrectly), in a sequence of re-engineering steps, may substantially enhance (hinder) overall cross-sectoral progress towards more sustainable city-watershed systems. We should add a fourth axis here to the 3-dimensional sub-space of (T9) to reveal such latent synergies (or their antagonisms), as matters integral to gauging sustainability:

- interactions, with co-dependence⁶³ between the provinces of antagonism and synergy.

Taking a look back to the start of all these threads, to that of our “existence” along (T1), and then further back to the person-centric outlook of Figure B2.1, the health and well-being of you or I are key. Inasmuch as we have asked there under (T1) “What elements of re-engineering urban wastewater infrastructure for CFG might bring the aspirations of individuals to a self-reflexive grasp of the ‘big picture’?” (the corresponding entry for (T1) of the *TBL_{future}* in Table 2), so might there be a case for introducing (here) the pharmaceuticals and health-care sector into (now) the multi-sectoral analyses of (T9) (ICSU, 2011;

Warner Babcock Institute for Green Chemistry (www.warnerbabcock.com; accessed 10 March, 2011)).⁶⁴

(T10) Space

We are bidden to “think globally, act locally”. Thinking is to be propelled forwards and outwards from the confines of the wastewater treatment plant, across the province of the *TBL_{now}* for IUWM (to which the entries of Table 1 are largely attuned), and on to that of the watershed and IWRM, if not then the world (and the *TBL_{future}* of Table 2). Far out along this spatial axis reside the abstractions of IUWM and IWRM. But for the reminder to “act locally”, we might easily forget the highly personalized “you or I” of the stick-figure icon of Figure B2.1, and the thread of intimately personal and most local of aspirations with which we began under (T1), at the origin (in space).

(T11) Life Cycle and Time

A life cycle is taken to run from the cradle to the cradle: from conception and planning, to design, construction, operation, disassembly and upcycling, and reincarnation. It is subsumed under one *generation*, one province of an axis employed already. To generations of man and animal in (T6) and (T5) can now be added generations of manufactured capital. The very concept of life-cycle was itself born of drawing the analogy between engineering projects and biological organisms. To introduce another axis — so obviously the number of life stages *and* their cross-stage interactions — might amount to little more than merely subdividing an existing province along an existing axis into ever smaller parts, and three, in particular (as here). If we single out the stage of operations and label it (O), all that precede

⁶² As in Kytzia *et al* (2004) and Lang *et al* (2005), who attach flows of money to those of materials, to assess respectively alternative systems of food production and alternative recycling schemes for municipal biowaste (see also Malmqvist *et al*, 2010). The subsequent study of Villarroel Walker and Beck (2011a) examines the economic benefits that might attach to re-balancing the nitrogen cycle of the Atlanta-Chattahoochee system.

⁶³ In a randomized search of candidate technologies to occupy various niches in the stages of wastewater treatment it can transpire that the “fittest” is only such in the presence of another item somewhere else in the complex web of interacting, individual technologies (Chen and Beck, 1997).

⁶⁴ Warner’s work has been cited specifically in respect of reducing waste from the manufacture of a drug for Parkinson’s disease (see “EPA Scientist Advocates ‘Green Chemistry’”; <http://marketplace.publicradio.org/display>, posted 23 March, 2011).

will have been the pre-operational stages of the life cycle (the (Pre-O)). All that follow add up to the (Post-O).⁶⁵

What matters here — and what matters to the entirety of this *Concepts Paper* — is bringing the spread of such ordered thinking to the table of a policy assessment for sustainability. Our purpose has been to recognize, straighten, and tie together the logical threads of such assessments, strictly according to contemporary practice. It has been neither to introduce bundles of axes for their own sakes nor to impress upon the reader that things must thereby be quantified in some customary mode of engineering analysis (such as the mathematical program of Chapter 2.5). To reiterate, Figure 17 is not numerical, but categorical. We have, however, now left behind the realms of the social and economic sciences, to find ourselves on the more familiar grounds of engineering analysis, where axes — time here (T11); space above (T10) — barely merit much further explanation or the bulleted formatting of the twenty or so axes already introduced.

The logical thread drawing TBL_{now} out towards TBL_{future} is cast in terms of the extent (lesser-greater) to which formal, more or less detailed, consideration is devoted at any given stage in the life cycle to that which might happen, be needed, or prevail at any subsequent stage. Such *forethought* is the essence of the “cross-stage interactions” cited above as a possible province along the generations axis. It is also the stuff of “the long and short of it all” at the beginning of Chapter 3.3: of not separating out one or more constituent life-stages for consideration in isolation. It has been the way in which (Pre-O) has historically received so much attention at the expense of (O) and doubtless — before we conceived of Life Cycle Analysis (LCA) — the way in which even less attention would have been given to (Post-O) during all the years of living with (O).

Life cycle and time work in somewhat different ways. The numerical assessments in Chapters 3.3 and 3.4

⁶⁵ No-one will be surprised by this. It is humbling too to reflect on the fact that my fixation on the operational stage in the life-cycle occupied significantly more than a quarter of a century of my own professional life cycle (Beck, 1981, 2005). Such fixation has here been the wellspring of Box 1 on “Schools of Thought: Styles of Engineering Sustainability” and yet again of Box 3 on “Engineering Resilience into the System”. There is some comfort, however, in seeing that the operational stages in each of three alternative systems for supplying water to the city of Phoenix, Arizona, USA, dominate the environmental impacts occurring over the life cycle of each (Lyons *et al*, 2009).

compared the {environmental benignity} of the current Business-as-Usual (BaU) configuration of wastewater infrastructure for the city of Atlanta with that of a future Perfect Fertilizer (PeFe) arrangement. They did so on the basis of operational (O) performance alone. The sustainability of $PeFe\{O(t_{75})\}$ was compared with $BaU\{O(t_0)\}$, taking the span of three generations to be 75 years (for the sake of illustration). Assuming that the policy/technology intervention of re-engineering for source separation was a single event, occurring hypothetically in future year t_i (again for simplicity of illustration), no account was taken of:

$BaU\{Pre-O(t^-)\}$, i.e., the sustainability of the sunk investment in the infrastructure of BaU prior to the present (for all (t^-) before t_0); or

$BaU\{Post-O(t_i)\}$ when dismantling BaU; or

$PeFe\{Pre-O(t_i)\}$ when putting in place the new PeFe arrangements.

The companion algebraic caricature of LCA would be this: that it compares, say, $l = 1, 2, 3$ distinctly different options for the PeFe configuration, i.e., the respective sustainability of the three $PeFe_l\{Pre-O(t_i); O(t_i); Post-O(t_i)\}$.

Within the grand, strategic sweep of affairs in the city, as it moves away from unsustainability ($BaU\{O(t_0)\}$) towards something less so ($PeFe\{O(t_{75})\}$), innovations are born. They rise, fall, and are returned to whence they came: the life-cycle of $PeFe_l\{Pre-O(t_i); O(t_i); Post-O(t_i)\}$. Their place is taken by other innovations, which too have their finite time and place. Life cycle and evolution over time are different, yet complementary “angles of insight” into what it might take to attain a CFG.

To the degree that (O) is a lengthy stage in an entity’s life cycle, so will inter-generational considerations be drawn into the frame of analysis, albeit here now in terms of assets and capital, as opposed to generations of humans. The corresponding entry for the TBL_{now} in Table 1 acknowledges this in the intention to set aside funds from (current) revenue streams not only for “reserves” (for asset management, future maintenance and renewal) but also for Research and Development (R&D) on future technological innovations and adaptations (Sahely *et al*, 2005).

(T12) Function

Things have been conceived of, planned, designed, and constructed or manufactured. They are *in situ* and working. Large or small — from entire eco-systems, to infrastructures, unit processes, individual technologies, to single devices — all must fulfil various functions in various modes of operation. There are sub-divisions of function and performance to be staked out within the sole sub-province of operations (O) along the life cycle of (T11), in turn itself but a province of the axis of generations (from (T6) or (T5)).

These are also sub-divisions of qualitatively different styles of behavior over time, such as those dotted about the quadrants of potential surfaces of dynamical stability-instability in Figure 3, some with, some without their inherently nonlinear “tipping points” (in contemporary parlance). At bottom, knowledge, including *foreknowledge* (again), is required in three categories: the unsteady-state, i.e., dynamic, behavior of the system; the desired goals for services delivered and functions performed by that system (outputs y); and the bundle of present and future disturbances inclined to upset, interrupt, or undermine such service provision (inputs u). In all three categories the status of knowledge may range across the continuum of complete-incomplete, including more or less complete knowledge about the nature of the uncertainty in an incomplete knowledge base (Beck *et al*, 2009).

Sustainability of function (T12) can be assessed according to at least three levels of progressively greater depth, subtlety, and intricacy, i.e., assessment for:

- (i) The provision of a single function (y , as scalar not vector), from a completely understood device or system (model M , which relates all u to single y , is perfect), such as a clockwork mechanism for marking the passage of time, under normal disturbances (u_{normal}) — the quintessence of engineering resilience (Box 3).
- (ii) The provision of all of the multiple functions (y), from an incompletely understood device or system (imperfect M), such as the microbial ecosystem of activated sludge in wastewater treatment, under both normal *and* abnormal disturbances ($u_{abnormal}$), i.e., the maintenance of function with ecological resilience (also Box 3).

- (iii) The adaptation of function — *not* form or structure — to the provision of entirely novel services (different y , same M and u). These will be services *not* in mind for the device or system in its preceding stage of construction/manufacture (Pre-O). Their conception will originate in the self-awareness of accumulating operational knowledge of the system, its disturbances, and its scope for novel functions, i.e., from (O). This self-awareness, furthermore, will be accompanied by the function of learning, which in turn may span the gamut from passive to active.

Parts of this last would be referred to in Box 3 as a strategy tending towards “0% reconstruction”.

We might further suppose the performance of the device or technology would culminate in some supreme capacity for mimicking the auto-immune system of the human body, the biological model of sustainability. Such immense richness of function would be almost infinitely remote from the origin, along any axis of quality of function. Failure by whatever means — through incomplete knowledge (imperfect M), abnormal disturbance ($u_{abnormal}$), or passing of a tipping point in behavior — would return quality-of-function to its minimalist province, at the leftward pole of the utter poverty of (non)function.

The corresponding entry for the TBL_{now} in Table 1 acknowledges some facets of the above virtues:

durability, i.e., a longer operating life-span as a consequence of no intrinsic tipping point being passed in the structural integrity of the system — in other words, maintenance of function in the presence of the very slow, seemingly invariant, dynamics of the material properties of a device (such as corrosion, which slowly but surely will lead to failure);⁶⁶

robustness-vulnerability, i.e., the capacity to absorb shocks or otherwise (from ($u_{abnormal}$)), while maintaining function (delivering y); and

reliability, i.e., the capacity to avoid failure.

⁶⁶ A case of Holling’s lyrical slow variables (dynamics of corrosion) determining what eventually happens very swiftly indeed (fast variables describing sudden rupture and failure) (Holling, 1996).

(T13) Gauging Environmental Benignity

Rooted within IUWM, the TBL_{now} of Table 1 categorizes output emissions from the city's wastewater treatment plant along the lines of the pollution syndromes found in LCA (Pennington *et al*, 2004), such as eutrophication, acidification, and global warming, for example. These rejects from the city are gaseous, aqueous, or solid and destined respectively for the atmosphere, hydrosphere, or lithosphere. The economic input output (EIO) LCA of Britton *et al* (2007) well illustrates this. They show that struvite (fertilizer) recovery from a wastewater treatment plant can reduce by typically 70-80% the emissions of gaseous pollutants (SO_2 , CO , NO_2), greenhouse gases, and solid contaminants (Cd, Cr, As), relative to corresponding emissions from conventional fertilizer production.

In the life cycle of a product, process, technology, or configuration of wastewater infrastructure, “stuff” is entrained as input (u) and shed as output (y). Resources are depleted and pollutants emitted in tandem with the fluxes of the [u, y] couple. All manner of “china” in the environment is being broken by the “bull” of a city as it charges destructively about.

From the negative of this nature, so readily conveyed in the drama of its ecological footprint, an assessment of the sustainability of the city would be seeking actions of re-engineering for restoring the conduct of affairs to a balance of zero: a condition of fragile, valuable entities preserved unbroken for ever. The sentiment is that of “righting a wrong”, of being “less bad”, *ergo* of “maximizing eco-efficiency”, with a hint of thinking about the environment in the language of business (T7).

Looking above and beyond to fashion outputs from the city that enhance the performance of its environmental surrounds — inching them beyond the origin into a positive province of this axis of environmental benignity — has been the struggle of this entire *Concepts Paper*, and Chapter 3.4, in particular. It has the positive spin of building natural capital and enhancing ecosystem services. It has much of the sentiment of eco-effectiveness about it, of being “more good” as opposed to “less bad”, as McDonough and Braungart (2002) would argue.

(T14) Cycling of Materials

Eco-effectiveness embodies the slogan of “waste = food” (McDonough and Braungart, 2002), along the lines of industrial ecology. Thread (T13) evokes an image of materials propagating from one end to the other of disconnected segments of arcs. These can be joined up (“waste becoming food”), to complete the cycling of those materials.

With this accomplished, one cycle, extracted from all others, may be considered on its own: the hydrological cycle, because it is so inevitably dominant in IUWM, IWRM, and the commercial *water* sector as a whole. Apprehension of the prospect of climate change has achieved widespread, popular appreciation of the carbon (C) cycle, to which the water cycle can be coupled — and so on, inter-coupling the water and C cycles with those of other nutrients (N, P, Si, etc.). As in Figure 17 (and Figure 16(a) before it), provinces along an axis of materials — already used in (T8) — may be sectioned off. Starting from the crudeness of recognizing no such “closed loop” of cycling, would constitute a rudimentary, unrefined analysis at the leftward boundary of the axis (U). Rightward movement of increasing refinement of assessment would pass over provinces successively acknowledging one, two, three, and eventually n jointly assessed cycles. To these might be added further embellishment in order to accommodate sub-divisions between natural nutrient cycles and *technical* nutrient cycles for xenobiotic substances (Azar *et al*, 1996; McDonough and Braungart, 2002). There (at (R)), assessments of sustainability would be far from the opposite pole (U) of disconnected fluxes in arcs that are not parts of loops that are closed.

A single point of diversion from these cycles, or appropriation of them, or fragment of arc along one of them, is recognized in the corresponding TBL_{now} of Table 1: consumption of resources, water, nutrients, energy, possibly “soil fertility”, as they are drawn into the construction and operation of the system (typically, a wastewater treatment facility) or “consumed” by virtue of their occupation (land area).⁶⁷

⁶⁷ Global warming and carbon footprint, deriving from the intimate nexus of the urban water-energy sectors, are nevertheless prominent in the indicators and criteria (TBL_{now} , in effect) of Sahely *et al* (2005).

Our Bottom Line

Contemporary practice in Triple Bottom Line accounting for IUWM within IWRM has been consolidated according to the *TBL_{now}* of Table 1. The dense structure of this tabulated material — and the preceding paraphernalia of logical threads, axes, and provinces — have been crafted to enable an extrapolation: of how the *TBL_{now}* might evolve into a *TBL_{future}* of Table 2. Should this lead to a better appreciation of what constitutes sustainability, it will have served its purpose. All the paraphernalia might be set aside, like the preserved exhibit of the rock-boring machinery that had once enabled the UK and France to be connected *via* the Channel tunnel.⁶⁸ For now, however, the beast of complexity has not been tamed. Indeed, to our dismay, all the entries in Table 2 for the *TBL_{future}* should strike us as altogether more subtle, more complex, and more multi-faceted than their counterparts in the *TBL_{now}* of Table 1.

But Table 2 is markedly different in structure from Table 1. It has a *fifteenth* and — quite deliberately — *topmost* line. The phrase “Organizational Learning” has been added, as a notional (T0), and the phrase “Always Learning, Never Getting It Right” inserted alongside it.⁶⁹

5.2 Truly a First Among Equals?

In their 2009 book “*Immunity to Change: How to Overcome It and Unlock Potential in Yourself and Your Organization*”, psychologists Kegan and Lahey present an “updated view of age and mental complexity” (Kegan and Lahey, 2009). Where previously just two levels of mental complexity had conventionally been recognized — in the socialized mind and the self-authoring mind — now, they argue, there is neurological evidence of a third and higher state of mental complexity. This they call the self-transforming mind. In their view, the evidence from brain science of the brain’s “phenomenal capacity ... to keep adapting throughout life” has caught up with what they had long supposed to be the case, since they first started reporting the results of their psychological assessments of individuals in the 1980s. Some of the evidence from brain science — albeit perhaps at the extremes — is reported in the work of Davidson and colleagues (Davidson, 2004; Davidson and Lutz, 2007). They have shown that “over the course of meditating for tens of thousands of hours, the long-term practitioners [of meditation] had actually altered the structure and function of their brains” (Davidson and Lutz, 2007).

By way of introducing their case for the uppermost level of mental complexity, Kegan and Lahey (2009) opine:

When we experience the world as “too complex” we are not just experiencing the complexity of the world. We are experiencing a mismatch between the world’s complexity and our own at this moment.

The observer of Tables 1 and 2, the reader of the foregoing Chapter 5.1, indeed any reader who has struggled through the entirety of this *Sustainability Concepts Paper*, will know the feeling. Kegan and Lahey go on to state the obvious:

There are only two logical ways to mend this mismatch — reduce the world’s complexity or increase our own. The first isn’t going to happen. The second has long seemed an impossibility in adulthood.

The self-transforming mind, of course, is the actuality that breaks through the supposed barrier of the “impossibility”. S/he who somehow cultivates a self-transforming mind becomes not just a leader, but a

⁶⁸ Rail passengers could witness the retired machinery just before entering the tunnel from the UK side.

⁶⁹ “Always Learning, Never Getting It Right” was the original title of what became “*Organising and Disorganising: A Dynamic and Non-linear Theory of Institutional Emergence and Its Implications*” (Thompson, 2008a).

“meta-leader”, who “leads to learn”(amongst other talents). Hence we have the entry of such into Table 2, to accompany that of “Always Learning, Never Getting It Right”.

We here might grant mental complexity the status of that of an axis for (T0), if it is to be an organizing thread of a sustainability assessment. It has three provinces, just as plotted, as three plateaus, along the axis of mental complexity in the Kegan-Lahey book:

- mental complexity, with provinces in ascending order of the socialized mind, the self-authoring mind, and the self-transforming mind

The self-transforming mind (Kegan and Lahey, 2009)

is *wary* about any one stance, analysis, or agenda

is mindful that, *powerful* though a given design might be, this design almost inevitably leaves something out

is aware that it lives in time and that the world is in motion, and what might have made sense today may not make as much sense tomorrow.

Placing the “self-transforming mind” at the very top of Table 2 for the *TBL_{future}* signals approval of it as a desirable attribute. After all, once thus revealed to us, who would want to settle for the quiet life of the socialized mind (being a “faithful follower”), or even that of the self-authoring mind (basking in the contentment of having “learned to lead”)?⁷⁰

Situated appropriately adjacent to the thread of personal aspirations (thread (T1)) in Table 2, the self-transforming mind might approximate what Maslow (1943) had long ago intended for human motivation in his uppermost need of “self-transcendence”. When therefore Kegan and Lahey (2009) write of the

⁷⁰ I have long thought the same about Cultural Theory (CT): that once revealed to all, could anyone then persist in being radically individualist about one thing, or rabidly egalitarian about another? Yes, I suspect, is the answer. In fact, all has now been acknowledged as revealed in Ingram and Thompson (2010). What Kegan and Lahey (2009) say of being “wary about any one stance, analysis, or agenda” has not escaped my notice either, in respect of the dominance of CT in this *Concepts Paper*. Elsewhere, Termeer (2009) seeks water experts who may become public leaders — leaders of movements who “want to make a difference”. One imagines these individuals might need the self-transforming mind.

self-transforming mind as something that “holds contradictions”, might this be what was to be sought under (T1), as here one of our greatest ambitions: a policy of re-engineering for CFG (IUWM, or IWRM) that brings with it appreciation of the “big picture” (thinking globally) and the inclination to debate the good or ill of sustainability? That is to say, given the Kegan-Lahey wariness of any one stance, analysis, or agenda, should we not be most wary of sustainability itself, as some “grand design” for everything? Thus derives the entry of “entertaining self-contradiction, including abandoning a line item, even ‘sustainability’ itself” into the topmost line (T0) of the *TBL_{future}* in Table 2.

We began our enquiry into the customs and conventions for assessing sustainability by looking to those line items of Tables 1 and 2 that come from the social sciences. We acknowledged their pre-eminence in legitimating what would otherwise have been the raw (brutish, for some) interventions of engineering and technology in moving circumstances away from unsustainability in the water sector and towards cities as forces for good in the environment. Now, towards the end of this chapter, we wish to reverse this precedence, to ask: how should the interventions of engineering and technology be fashioned in order to elevate our standing in respect of the existential thread of personal aspirations, of citizen participation, of social bonds, and of quality in governance? Such policies of re-engineering would be interventions beyond those of the internet and information and communication technologies (ICT), which so self-evidently are profoundly influencing social discourse and interaction. Innovations in ICT have a crucial role in arguably the most critical of all individual, personal aspirations, i.e., a grasping of the “big picture”, with which indeed to debate the good or ill of sustainability itself. Achieving that would be no less, in some ways, than what motivated engineer Gantt in a bygone era (as reported in Florman, 1987). Yet fashioning those interventions we seek today should itself be shaped and guided by the concepts and practice of sustainability, as we see it today — perhaps better, if we are blessed with a self-transforming mind, as we might begin to imagine it for “tomorrow”.

There is something troubling about all this, however. We have wrestled our way through the dense and expansive tangle of complexity about sustainability, to express Tables 1 and 2, as templates to be *followed*

in moving matters away from unsustainability: as if a *routine* so perfectly made for the “socialized mind” — which we then rank as bottom-most in any personal aspirations an individual might have to better herself or himself. Is there a lack of humility about the supposed inspiration and creativity of the self-transforming mind? Or does it contain self-redemption within it, at its core, in its capacity to strike down the edifice it may so painstakingly have built up?

Every so often, thou shalt abandon any one of the threads (T1) through (T14) and replace it with something other!

Should (T0) come with just such an invocation?