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21 A Synthesis Chapter

The *Incodys* Water Security Model

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Introduction

Indebted to the book's authors and inspired by their arguments and ideas, this concluding chapter reflects on the idea of 'water security'. My objective here is to make sense of the chapters in this book and literature elsewhere by proposing that water security and insecurity are not necessarily polar opposites; that water security need not be the opposite or 'converse' (Grey and Garrick, 2012) of water insecurity.[1] Rather, by establishing two gauges of water security (sufficiency of water security and equity of water security), *four* conditions of water security are proposed, hinted at in the title of this chapter (*incodys*). First, 'in' is shorthand for *insecurity;* second, 'co' is short for *collective security,* and third, 'dys', implying inequitable security, is short for *dys-security.* The fourth condition is *co-insecurity*, but this is not repeated in the title. The use of these terms also invokes the idea of *a-security,* implying the lack of an issue of water security, which is briefly discussed in the chapter.

Readers will therefore recognise the conceptual nature of this chapter; the ideas contained here are theoretical and intended to summarise this book's thinking on water security. The *incodys model* (as I term it) allows, amongst other matters, the consideration of how metrics and indicators might inform water security. Furthermore, and despite cautions levelled in Chapter 1 against single definitions of water security, I use this analysis to offer an explanation of water security: 'In creating four conditions of insecurity, co-insecurity, dys-security and co-security, placed in a two-axis graph of "sufficiency" and "equity", water security is viewed as a transitive space of water securities through which a community, individual, or system moves as a result of natural and human water-related drivers'.

However, despite this move towards synthesis and conciseness, I reiterate that water security is sufficiently complex to warrant multiple understandings; that, too, is one of water's defining qualities. It would be rash to claim that the model proposed here comprehensively reflects the many social, economic, and environmental dimensions of water and water management (a viewpoint at the centre of Zeitoun's web analysis). This sense of complexity is also captured in the UN-Water (2013) brief on water security. Thus, this chapter attempts to steer a path between a linear conception of a single

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axis of insecurity–security and a wholly complex multiple 'nth' dimensional abstract space of composite axes and indicators of water security. My 'middle path' solution is to formulate water security as a two-axis understanding of water security that can be graphed on a standard *x–y* axis graph. This graph, in turn, gives rise to four conditions of water security, introduced above and explained below. The other option of selecting three gauges of water security (for example sufficiency, equity, and productivity) is partly discussed in the chapter; however, this would require a three-dimensional cuboid representation of water securities and the possible formulation and naming of *eight* water security conditions.

Initial Insights: Water Security 'Opposites' and 'Transitions'

To lay the groundwork for the *incodys* model, I begin with three key distinctions. First I argue that water security need not be 'the opposite' of water insecurity. In other words, there is not a single linear scale between water insecurity and water security. This point regarding multiplicities is also echoed by Boelens (Chapter 15) who discusses 'divergent water securities'.

Second, similar to the first point, there are places in the world where water security and insecurity are not an appropriate frame to view the water situation. This is where patterns of supply and demand are purely 'natural' with no or a very small influence or anthropogenic demand from society. This idea, described by the term *a-security,* further indicates the limitations of a linear scale reaching from insecurity to security.

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Third, I am interested in water security actions and 'transitions' suggested by the term *water securitisation*. 'Transitions' implies a shift from one state to another state, for example, from insecurity to security. However 'securitisation' is not necessarily the process of making human and ecological parties water secure; it is not the action that assures water security. This is because, following this book's authors (e.g. Leb and Wouters, Chapter 3; Zala, Chapter 17; Zeitoun, Chapter 2), I interpret securitisation in a highly strategic and controlling sense (both making water the object of a security concern then pursuing forms of appropriation). For example, securitisation of water for a nation is seen by Leb and Wouters as highly political and at the possible cost of neighbours when sharing a transboundary watercourse. Hepworth and Orr (Chapter 14) also warn of private benefits accruing to corporates from securitisation. I therefore retain securitisation to mean the removal of water scarcities and vulnerabilities for few, usually powerful and hegemonic parties leaving other, usually less powerful and more marginalised parties more vulnerable.

Drawing from these three distinctions, one can clarify and reiterate seven points. One is that *water security* is a term that invokes a sense of being somewhere, being in a state, or facing a certain condition. For example, a community might be 'water insecure'.

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Second, water security also invokes the sense of change and transition—either actual change (e.g., being in a drought) or the chance of forthcoming change (e.g., being in an environment prone to drought).

The third insight, closely related to the first two, is that water security invokes the idea of gradation—that there are grades of difference between a wholly insecure context and a wholly water secure context. Following Mason (Chapter 12), these grades of difference might be discernible if indicators are appropriately designed and measured.

Fourth, stepping back, society and its decision makers must discern under what conditions the idea of water security arises. In other words, in the rush to frame water via water security (drawing on Cook and Bakker's identification of the rising usage of the term), we forget to consider situations where water security is a nonissue and how this informs the idea of water security. The term *a-security*, alongside the *incodys* framework, helps make this distinction (see later).

Fifth, one might argue that the ideas of 'to be water insecure' or 'to be water secure' (and the grades in between) suggest a classification of different types of water *securities* (Boelens, Chapter 15). This classification is developed in the *incodys* model. Therefore, a community can find itself facing a given set of water conditions (e.g., at the risk of flooding, or having less water than required, or facing poor water quality) and, assuming this can be measured, the community's condition can be classified accordingly.

Sixth, from previous points emerges the idea of action or intervention, for example, in making an insecure community more secure. In other words, there is an intention to improve the conditions a community faces—to make things better. This 'doing' propels a given party along a trajectory and invokes an idea of transition(s) and of a governance of these transitions. Boelens (Chapter 15) expresses this as 'realizing water security', although 'doing' also covers situations when conditions become more insecure.

Lastly, from these observations and from a desire to steer a path between oversimplification and overcomplication, I consider two scales or gauges that seem to be of major significance in water security. These two scales, termed *sufficiency* and *equity,* create a two-dimensional water security '*incodys* space' (described later). Sufficiency implies sufficient quantity and quality of water and sufficient protection from excessive quantities of water. Thus, 'sufficiency' is inferred by Grey and Sadoff (2007) as "the availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production" (p 545) and considered by Cook and Bakker (Chapter 4) to occur when " [a human] has access to sufficient safe and affordable water". Sufficiency is also considered in terms of accessible water of a good quality being connected to the human right to water, recognising water's centrality to health, the home, and production (Chenoweth et al., Chapter 19; Zeitoun, Chapter 2). The idea of sufficiency/sufficient is also exposited by UN-Water (2013) as central to water security for humans (and the human right to water; see also Leb and Wouters, Chapter 3) and for the mutual connections between healthy ecosystems and

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societies. Control of floods or protection from floods is also part of sufficiency. Multipurpose infrastructure for flood protection (as well as drought provision and hydropower) is identified by Mirumachi (Chapter 11) and Garrick and Hope (Chapter 13), while Warner (Chapter 18) adds to this by correctly drawing out the political provenance of the notion of sufficient flood protection. Finally, sufficiency should recognise the multiple types of water (e.g., soil water, groundwater) that society draws upon (Falkenmark, Chapter 5; Allan, Chapter 20).

Equity is the other major axis or gauge, and is implied when Zeitoun (Chapter 2) asks the question 'water security for whom?' Tickner and Acreman (Chapter 9) argue that social and economic security is not possible without environmental and ecological security. Hepworth and Orr conclude their analysis of the involvement of corporates in securitising water to meet their profit interests by suggesting a more sustainable notion of mutuality: "navigation between corporate securitisation and stewardship of the water commons, towards a more genuinely shared, wider water security" (Chapter 14). Garrick and Hope (Chapter 13) point not only to risk but also to the sharing of risk. The idea of equity is central to Boelen's (Chapter 15) whole chapter; in his first sentence he links water scarcity and insecurity to the ways water and water services are distributed rather than absolute availability of water. Confirming equity and equitability as strong themes running through Leb and Wouter's chapter, as key underpinnings of transboundary water law, the proposition of ' water justice' (Clement, Chapter 10) also picks up the distributive dimensions of water security. Equally, the 'working definition of water security' (UN-Water, 2013; p1) implies equity (but does not mention it directly) by referring to water's different interests and benefits: sustaining livelihoods, human well-being, socioeconomic development, and preserving ecosystems.

Water Security Hydro-Physical Outcomes—Six Measures

The *incodys* water security model, described in the next subsection, describes a transitive space made up of two axes of sufficiency and equity. However, to place a water community, system, or situation into this transitive space requires selected indicators to be measured and assessed. Table 21.1 and Figure 21.1 arrange six water security indicators within the two classes of sufficiency and equity. Each of the two axes and their three respective indicators are discussed below.

Table 21.1 suggests examples of metrics that might assist in defining indicators that can be measured or classified, and confirms the hypothesis that the *incodys* model primarily describes hydro-physical measures of water either as dimensional ratios (such as available water per capita), dimensionless ratios (e.g., measures relative to a physical standard), measures of difference (e.g., variations in supply or protection), or as categories (e.g., pass/fail) or as count data recast as percentages (e.g., the number of community households satisfied with their water provision).

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Table 21.1 Definitions and measures of water sufficiency and equity/justice

Main axis	*Indicator*	*Details*	*Example units*
Sufficiency	Volumetric sufficiency	Exact or relative measures of per capita water availability	Cubic metres per capita
	Water quality	Exact or relative measures of water quality (e.g., pollution, turbidity, salinity, oxygen), or measures of client satisfaction in urban areas	Classes (high, good, mod, poor, bad)
	Flood protection	Risk map of protection from flooding (distance-depth for example)	Depth, extent, risk of event (e.g., return period)
Equity/ justice	Water allocation/ equity	Bulk water allocation between sectors; measures might include difference from expected or variation measures such as the Christiansen coefficient, interquartile ratio, or coefficient of variation	Exact % ratios relative from expectation or history; measures of difference
	Dynamic apportionment	Scarcity allocation during drought or when levels of supply change dramatically and dynamically; low flow ratios and access measures during drought might apply	Percent coverage of minimum requirement; measures of difference
	Productivity/ efficiency	The specific production from units of water and/or land/ labour using carefully accounted denominators of withdrawal and/or consumption	Unitless efficiency; economic or biophysical productivity

As explained elsewhere, social, political, and economic measures could also be collated and analysed and would very much support the physical character of the *incodys* model. Furthermore, nonphysical measures could also be arranged under two criteria of sufficiency and equity. For example, taking water laws and agreements, one could analyse whether they were sufficient (in number and detail) and equitable (in terms of their intention to support or undermine the physical apportionment of water to different users and sectors).

Table 21.1's grouping within two themes agrees with Mason's advice: 'then the emphasis should rather be on reducing the variables of concern, and the complexity in how they are amalgamated' (Chapter 12). Critical to the coherence of the *incodys* approach are indicators that are closely grouped conceptually—in other words, that are commensurate to each other and to their meta-indicator of either sufficiency or equity. The two

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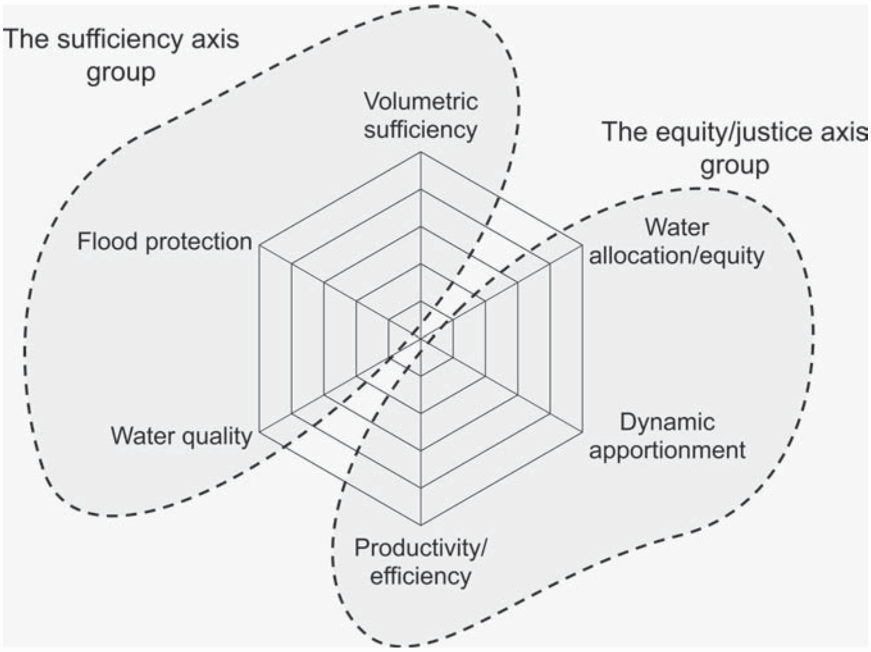

Figure 21.1 The hexagonal radar chart of water sufficiency and equity

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significant weaknesses of the water poverty index (WPI) (Sullivan, 2002) stem from the incongruity of the five indicators selected (resources, capacity, use, access, environment) and the disparate constituents by which these five indicators are measured (Mason, Chapter 12; Molle and Mollinga, 2003). In searching for an acceptable level of commensurability (see also Cook and Bakker), the *incodys* model differentiates hydro-physical measures from other socioeconomic metrics and amalgamates the six subindicators into two themes of sufficiency and equity.

Furthermore, as expressed elsewhere in this chapter, the interpretation of these measures (both in terms of selection/design, but also their meaning) should be clearly acknowledged as being relative and subjective. The *incodys* model is very much intended to be a dialogue tool and decision aid; who gets to select the measures, to reflect on them, and to employ them in classifying a system should be transparent and highly processual.

The Sufficiency Axis Group

The sufficiency axis primarily speaks of biophysical outcomes related to infrastructure designed to remove constraints to insecurities generated by inadequate water quantity, poor water quality, and excessive flood risk. In other words, water systems on this axis grade from 'insufficiency' on the left to 'sufficiency' on the right. Clearly not all of these attributes (quantity, quality and flood) might exist contemporaneously; indeed, water scarcity and floods might be mutually exclusive. (Recall whether and how these physical

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attributes are managed so that water and water benefits are 'shared out' between water users is covered by the equity/justice axis – see below).

- *Volumetric sufficiency.* The objective here is to assess whether water demand is adequately provided for by a combination of supplies of water including surface water, groundwater, rainwater/green water (Falkenmark, Chapter 5), desalinization, and virtual water (Allan, Chapter 20). Volumetric sufficiency is linked by chapter authors to, for example, human security (Falkenmark, Chapter 5), food security and production (Clement, Chapter 10), and to sustainable cities (Earle, Chapter 7). Given the subjective, transient, and relative nature of demand, a locally derived measure of sufficiency is probably the most sensible route to take. Thus, for a selected system, water needs might be derived from its domestic, agricultural, and industrial functions, but validated against norms and standards taken from similar situations (or indeed with reference to international standards; Falkenmark, Chapter 5). Sufficiency measures of demand and supply can then be converted into a range of indicators such as a ratio/percentage (e.g., 125% would indicate a surfeit of 25% supply over demand) or as a ratio against an accepted standard (e.g., where 25% indicates a surfeit of 25% over a recognised scarcity limit).
- *Water quality.* Nearly all the contributors to this book argue either explicitly or in passing that water security includes water quality by invoking the idea of 'safe' water for human needs and/or sanitation (examples include Cook and Bakker, Chapter 4; Hepworth and Orr, Chapter 14; Zeitoun, Chapter 2; Chenoweth et al., Chapter 19). In addition, Mirumachi (Chapter 11) also considers water quality to be part of environmental needs, and Conway (Chapter 6) links water quality concerns to climate change. A number of pollutants and quality criteria might be considered in drawing up a single measure of water quality. Depending on location, typical concerns include: the presence of agricultural chemicals and poisonous compounds such as heavy metals and metalloids (e.g., arsenic in Bangladesh groundwater); low oxygen content; and waterborne pathogens that cause ill-health in humans and animals. Interventions to raise water quality include control and regulation and water treatment post and prior to abstraction or consumption. Scoring water quality might adopt the EU Water Framework approach of classes or a pass/fail system (Kallis and Butler, 2001; EU, 2012) or community definitions of acceptable standards and whether they are met or not (e.g., the number of hours spent fetching drinking water).
- *Flood protection/risk*. Authors identify risks associated with the damage wrought by flood (Warner, Chapter 18) and protection from floods (Earle, Chapter 7). For the purposes of the *incodys* model, a broad definition of flooding is taken, including heightened depths and destructive energies of water from stream flood events, persistent waterlogging, and combined freshwater and seawater level rises and surges. A variety of interventions and works grapple with the dangers presented by floods,

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including technologies such as inserting and/or raising bunds, providing river training, dredging and removing bottlenecks, adding safe storage areas such as floodplains, redesigning urban and industrial architecture, introducing improved emergency services, and effecting upstream land-use changes to the catchment. While these describe some of the management inputs, the outcomes measured for the purpose of assessing security from floods could utilise the Water Framework Directive model where classes of risk are mapped spatially, and from which, for example, some insurance companies derive their premiums.

Equity/Justice Axis Group

The equity/justice axis measures three different criteria that reflect the equitability and justice dimensions of water management. This axis promotes the idea of water sharing—either of water abundance or of water scarcity. Furthermore, this group of measures reminds water managers and decision makers that 'partial security' is not security, that those who gain at the expense of others might have their advantage questioned and removed.

- *Allocation.* This measure captures the idea of how bulk or annualised volumes are shared between different sectors or communities within a given basin, subcatchment, or country. Because allocation is a measure of sharing, and because uneven allocation must reflect a difference relative to practice or expectations, measures of allocation must be carefully defined. Coefficients of variation or of difference are likely to be incorporated into this type of indicator. Different emphases on blue and green water allocation (Falkenmark, Chapter 5) would reflect the types of systems being studied.
- *Dynamic apportionment.* Critical to the notion of equality is whether all users and sectors gain under two particularly challenging environments: one is during drought, and the other is during periods when systems are moving quickly between wetness and dryness. Dynamic apportionment is a suitable term that covers equitable distribution under such conditions. Both variability and drought are set to increase as a result of climate change (Conway, Chapter 6), and both provide opportunities for advantaged parties to gain in relative terms alongside others. As well as incorporating this idea in this book (Lankford, Chapter 16), three papers (Lankford, 2004; Lankford and Beale, 2007; Lankford and Mwaruvanda, 2007) elaborate upon how fast moving and stochastic nonequilibrium conditions allow upstream irrigators to unpredictably and disproportionally gain compared to others.
- *Productivity/efficiency.* Some might argue that productivity and efficiency are substantively a different type of descriptor of water systems, in effect creating a 'third' axis allowing systems to be described using the criteria of sufficiency, equity, and productivity. However, seeking purposively to keep with two axes and four water security states, I have joined productivity

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and efficiency to equity/justice rather than to sufficiency. This decision flows from the argument that well-shared timely co-managed water is likely to be more productive for users between and within sectors than if only a select few obtain 'their secure supply'. Nevertheless, as Clement (Chapter 10) hints, the economic argument for water to flow to the most productive sector (e.g., industry rather than agriculture) counters the sharing principle of this equity/justice axis. However, Clement's observation on economic efficiency suggests why biophysical efficiency might be linked to equity rather than to sufficiency or stand alone as a separate indicator. The principle at work here is one of allocating water on the basis of a level playing field so that potential (i.e., higher) biophysical efficiency not actual (probably low) biophysical efficiency drives both the allocation decision and the amounts of water transfers involved. In this sense, allocation is then seen as equitable (in the legal sense) rather than purely on the basis of political priority and a misapprehension that agricultural sectors are, de facto, inefficient. To exemplify: Low productivity irrigation comes under focus for allocation of water to another sector via raising its efficiency rather than deducting water from its net beneficial needs.[2] Indicators for productivity and efficiency can be generated from using either exact measures (e.g., crop per drop or dollar per drop) or relative measures set against local and achievable standards.

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The Incodys Water Security Model

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Using points made in the introduction and in the sections above, the *incodys* model of water security (Figures 21.2 and 21.3) utilises a two-dimensional field of water security constructed from 'sufficiency' and 'equity' based on six criteria given in Table 21.1. The *x*-axis is the sufficiency axis, while the *y*-axis depicts equity. Furthermore, it is the movement up the equity/justice axis (away from the *x*-axis) that invokes the idea of cooperation and collectiveness. Hence the naming of two conditions includes the prefix *co-* for those at the top of the graph where sharing and equity are expressed most clearly. This cooperative ethos is expressed by Zala (Chapter 17), Mirumachi (Chapter 11), and in words by Leb and Wouters: 'cooperation and not securitisation is at the heart of achieving effective water security'. One consequence from the two-axis model is the identification of four types of water securities, explored in the subsections below. The fifth condition, *a-security,* begins the discussion.

Water a-Security

Not graphed in either the radar charts of Figure 21.2 or the *incodys x–y* chart of Figure 21.3 is a condition of *a-security.* A-security is discussed first because it usefully distinguishes what the *incodys* model does and does not address. The *incodys* model primarily applies to situations where water demand and supply are in a state of balance/imbalance and where both demand and supply

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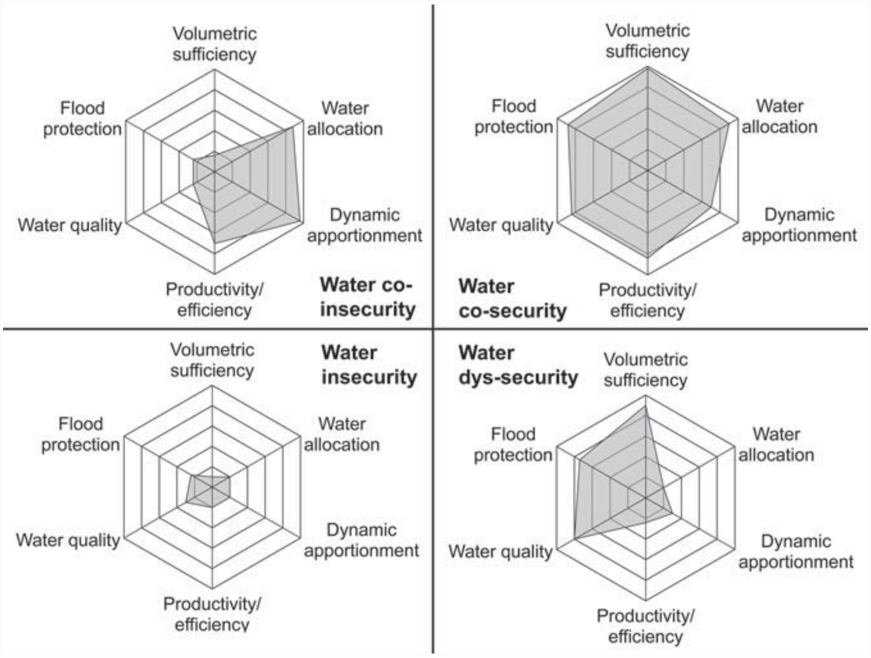

Figure 21.2 Four conditions of water security depicted in the radar charts

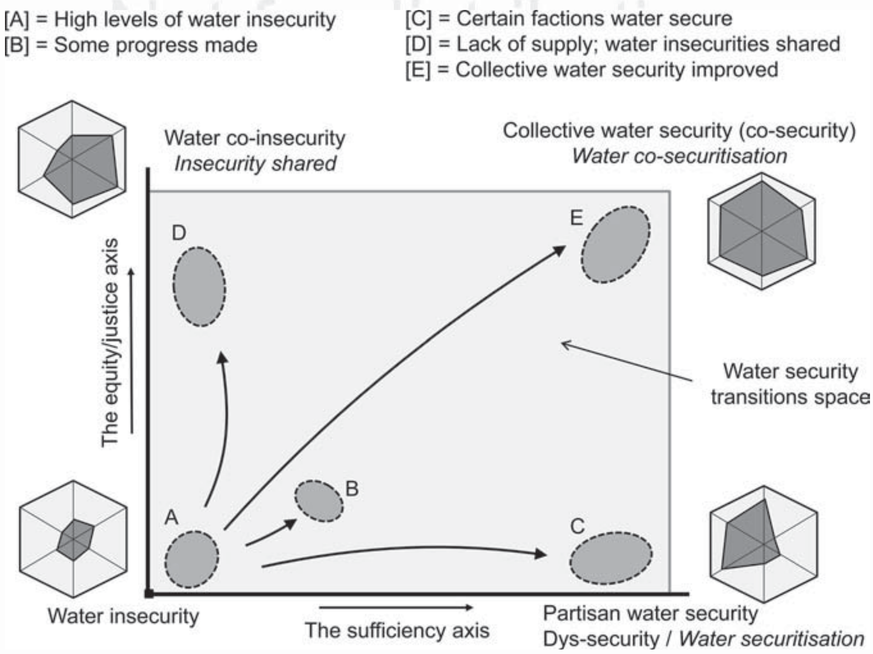

Figure 21.3 The *incodys* transitions space of water security

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are significantly shaped by anthropogenic influences (or where ecological concerns are represented by humans).

On the other hand *a-security* describes conditions where extant and future anthropogenic and ecological demands are predictably and quantitatively small. Examples of this in humid zones might be found in central rainforests of Amazon and Congo regions, which experience annual rainfall amounts of approximately 2,500 mm/year or more and where few humans live. At the dry end of the spectrum, examples of human absence and where nature is attuned to aridity are found in tropical, sub-tropical, and artic deserts, such as the Sahara. While there are communities in these environments that face water insecurities (pointing to the need for an appropriate scale focus), it would be questionable to impute the term 'water insecure' to environments predictably very dry or very wet inhabited by very few humans. However, a-security is subjective and in flux; future balances between supply and demand in a climate-changing and population-changing world are unpredictable.

Placing a-security prior to the subsections on the four conditions of water security prefigures the discussion below on perspectives: that while water security and measures of water cannot be arrived at objectively, we nevertheless should treat critically claims regarding water insecurity. The identification of four *incodys* securities and use of measurable indicators serve discussions that would otherwise poorly disentangle the interests and perspectives at work.

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Water Insecurity

Shown in the bottom left frame of Figure 21.2, water insecurity describes a condition of both insufficient and poorly shared water resources. This state arises because there is inadequate supply over demand, poor water quality with associated health impacts, and/or high risks of extensive flood damage. In terms of equity and justice, despite there being little excess water, some sectors gain at cost of others both during normal conditions and when droughts hit. Water productivity is low and uneven, which combined with reduced volumes of water, leads to low economic growth.

Water Co-Insecurity

Communities face water co-insecurity (top left of Figure 21.2) when scarcity, poor water quality, and/or the risk of flooding are shared more equitably between individuals, communities, and systems. Unfortunately, without good monitoring and communication, users experiencing water co-insecurity may blame their neighbours for over-consuming water; thus, in some situations, co-insecurity might 'feel' much like water insecurity. For example, without an emphasis on a sufficiency of good quality water, health impacts are still likely to be negative. Productivity, although likely to be more even and perhaps slightly higher than in an insecure situation, may not feed through to high production because of water supply constraints.

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Water Dys-Security

In Figure 21.2, bottom right, water dys-security is marked by highly uneven, partisan, and factional water security. Thus, although at one scale there is sufficient supply to meet demand, this has been captured by a few players or sectors. This has occurred because of geographic sequencing (for example, where large areas of irrigation lie upstream of wetlands) or because of imbalances in water law (where environmental demands are poorly recognised). Another example is found in parts of India where via a combination of technology and energy pricing, richer farmers have sunk deeper boreholes, leaving shallow tubewells supplying poorer members of the community. The particular feature about water dys-security is that these imbalances are felt throughout the hydrological regime from abundance during normal to wet years and during downturns and dry periods. Although flood protection and good quality water are afforded to some, the overall sense is that that some sectors of the community or environment are poorly provided for. Imbalances in water productivity are also notable, with the effect that in total the benefits of water are not optimised.

Water Co-Security

The radar chart for water co-security (upper right of Figure 21.2) views water and flood protection as sufficient for all parties and evenly shared between the parties involved. In particular, sectors and users are treated equitably when analysed using both bulk annual volumes and during periods of scarcity and rapid change. Furthermore, combinations of sufficient water (shared equally) with good quality clean water and flood protection also serve to boost water productivity, healthy human populations, and environmental goods.

Water Security Transitions

Figure 21.3 brings together the above states of water security into a transitions space. The first, 'water insecurity' is located in the bottom-left corner, characterised by insufficiency and inequity. In the bottom right-hand corner, water securitisation has delivered sufficiency to certain factions but leaves others insecure. In the top left of Figure 21.3, sharing delivers water co-insecurity more equitably yet parties still face forms of insufficiency. Finally, in co-security, towards the top-right of Figure 21.3, interventions improve sufficiency and sharing. Figure 21.3 shows a system hypothetically moving through this space from situation A (water insecurity) to C, D, and E, each relating to the four corners of the graph. Situation B offers an example whereby some progress is made, perhaps by the installation of a new water treatment works, but the community continues to argue that it remains short of sufficient quantities of water or that this better drinking water is more expensive and is not reaching all members of the community.

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Discussion

A number of observations can now be made about the design of the *incodys* model and how it might be applied. Readers are reminded that this conceptual framework is at an early stage of development and needs additional work on metrics and indicators using case material.

Socioeconomic Water Security Outcomes

I reiterate here that in the search for commensurability, the *incodys* model seeks to portray hydro-physical (e.g., cubic metres of water consumed by sectors) rather than socioeconomic outcomes (e.g., number of water agreements in place). However, this is not to downplay the latter. With respect to socioeconomic water security outcomes, a number of authors in this book identify examples. Outcomes include general health and poverty indicators (Chenoweth et al., Chapter 19); urban, industrial, and economic activity associated with water (Earle, Chapter 7); and impacts on other resources such as energy, land, and food (Froggatt, Chapter 8). The lack of space precludes further exposition; however, it is important to mention that these metrics are highly complementary of hydro-physical measures of sufficiency and equity.

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The Incodys Transitive Space

I have purposively not divided the *incodys* space into four exact quadrangles (or placed the axes intersection at the centre of the graph), as I believe this would mistakenly signal that exact and even thresholds apply to many if not all systems. Instead, I perceive the *incodys* model as being a dialogue tool to elicit and subsequently test subjective understandings of water security in relation to physical metrics. In other words, researchers using the model might discover that communities and individuals believe that insecurity occupies the majority of the space of Figure 21.3, leaving the notion of verifiable mutually agreed co-security a minor part of the field. Furthermore, the conceptual location of the fifth state of a-security is not placed in the *incodys* space because it does not arise through the criteria of sufficiency and equity of water security. In other words, because patterns of supply and demand are not significantly problematic (being almost entirely natural and without the presence of human concern), a-security sits outside of the *incodys* space.

Sufficiency and Equity Interactions

Early discussions of the model with Masters of Science (MSc) students on the UEA Water Security degree in March 2013 confirmed an array of interactions might exist between sufficiency and equity. One is that 'sufficient' water quality, quantity, and flood protection might automatically 'trickle down' into equity. Others viewed that these two dimensions need not be

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necessarily linked and that high levels of sufficiency might be marked by low levels of equity between parties. These views imply further work on whether the *incodys* model is interested in relative or absolute measures of water security. For example, a new large dam might generate greater benefits for more people (in absolute terms), but some members of society gain tremendously from this infrastructure compared to others.

Participation, Perceptions, and Metrics

Working with ideas of water security at different spatial and temporal scales will inevitably summon critical problems related to subjectivities and perceptions. As Zala (Chapter 17) writes: 'Particular attention must be given to addressing local-level perceptions of inequality and injustice, particularly in conflict and post-conflict situations'. Similarly, Garrick and Hope (Chapter 13) posit: 'Individual and social perceptions of risk are fundamental to decision making to manage water security risks and tradeoffs'.

For these reasons the *incodys* model promotes the collection and analysis of metrics as paramount objectives to inform the deliberative and participatory process that then attempts to reconcile disparate users' perceptions. It is the lack of substantiated metrics that make many participatory workshops somewhat hollow affairs. It should be noted that participation itself is not part of the *incodys* set of physical metrics, but it may be recorded as a socio-economic outcome.

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Insecurity Reversals

Further work is required on how the model might depict a severe reversal in water insecurity—as might happen during a protracted drought.[3] While one answer to this phenomenon might be a continuation of the axes into negative territory using minus numbers or the adoption of a logarithmic scale, I am more inclined to think that the *incodys* space is not anchored to a particular baseline. In other words, severe water scarcity would see the graph rescaled. This fits points made elsewhere in the chapter that the model is primarily a metric-informed dialogue tool.

Mapping Water Security at the Global Scale

Finally, because water security is made up of two themes, it will be highly unlikely that the *incodys* model can be turned into an index that can be used as a global map of water security. I judge this as a major benefit and caution against attempts to do so. World maps that 'find' damp Northern Europe to be one colour, zero rainfall Sahara desert to be another, Greenland to be blank, and the 'hotspots' of the Indus and Nile (for example) to be another colour are entirely unconvincing given that they miss the local detail of the multiple and transient aspects of water. The *incodys* model would, with its two axes, be difficult to transform into different colours. Thus, because of

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explicitly recognised problems of data, perspective, and temporal flux, a global map of *incodys* numbers or classes would be nonsensical.

Conclusions

Rather than rephrasing the overview offered in the opening chapter or identifying further work and spelling out gaps in this book (of which there will be many), this final chapter has drawn upon authors' chapters to propose a water security synthesis. This has applied a framework to distinguish between water security governance and water security. With regards to the latter, a two-axis formulation of water security, based on ideas of 'sufficiency' and 'equity', has been proposed. This in turn gives rise to an *incodys* transitive field comprising four states of water security: insecurity, co-insecurity, dys-security, and co-security. It has also grappled with the scope of water security considering that there are situations where, due to environmental circumstances and an absence of anthropogenic interests, no water security problem arises (so called *a-security*). Clearly this conceptual treatment of water security has left open many questions of how to define and measure sufficiency and equity and to govern water security transitions.

Notes

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1. I am more persuaded of the 'opposites' argument in the field of food security; that the 'opposite' of food security is food insecurity. This is because, in some respects, food is an endpoint while water is both something received but also consumed, nonconsumed, distributed, and passed on. The collective use and distribution of water, and therefore equity, is central to successful water management.
2. The aim of this discussion is to link efficiency//productivity to equity. Without doubt this logic in the real world would be messy and complex because of the difficulties in separating beneficial, nonbeneficial, and recovered flows.
3. I am grateful to Jenny Fraser (UEA MSc Water Security) for her question on the issue of water security reversals.

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