Where is the Coastline?

Interdependence and scale

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ABSTRACT: *Understanding the concept of interdependence means acknowledging myriad variables that assemble, separate, and redistribute in a virtual infinitude of relations. These interdependent variables, and the relations between them, can be seen as becoming perceptibly more abundant and volatile when viewed at finer, local, levels of scale. Conversely, they become simpler and more stable when viewed at cruder or macro-levels of scale. The question for policy and other practical applications, then, is which level of scale is most appropriate when dealing with any given interdependent phenomenon? Is it necessary to proceed with less "true" pictures at a cruder scale in order to foster more pragmatic results? These issues are explored through an analysis of the formulation and implementation of human wildlife conflict (HWC) policy in Bhutan. This exploration demonstrates that while HWC policy formulated at the macro-level contains an explicit focus on interdependence, when the policy is implemented at local levels of scale, much more complex tangles of interdependence emerge. These tangles obfuscate perceptions of the cause of HWC and, for some, drive opposition to a key value that is a foundation of the HWC policy. Drawing on the Bhutanese case, we advance ideas on how public policy and educational contexts can practically respond to the challenge of interdependence at different levels of scale.*

KEYWORDS: *Interdependence, scale, policy, Bhutan, human-wildlife conflict*

Until recently, in Eurocentric traditions, we have tended to misunderstand and underestimate interdependence, for at least two reasons. One, Aristotle inaugurated a presiding substantialist ontology in which both time and relations—*accidents*—are secondary features of a reality made up of constituent "things," where each thing has an inviolable "essence"—an interior core of identity shielded from interdependence. On such a view, independence is something that "happens" to things, not a fundamental generative force on its own. Two, Aristotle's ontology has proven durable as a set of unquestioned axioms for most influential Euro or "Western" scholars, and has, historically, suffused most Western domains of knowledge. [1]

True, the West has had a small share of anti-essentialist and process-relational thinkers, but they have had to spend an inordinate amount of time and energy attempting to explain themselves within cognitive frames of substantialism, a project doomed to failure, or to explain why those substantialist frames are deficient, a project doomed to fatigue, or to migrate their thought into fields like Theology, a project doomed to restrictive specialization.

More recently, however, a hundred-plus years of nonlinear mathematics and sciences, process-relational philosophies, climatology, and complexity theories—to name a few—have given us a more mature appreciation of nonlinearity, one more in line with the traditional Buddhist logics of the Tibetan Plateau or the Indian subcontinent, which eschew substantialism. Moreover, we have come to respect how sensitive nonlinear relations are to their conditions, and how dramatically those relations can evolve in real time. We've become accustomed to seeing the principles of interdependence acknowledged in diverse fields, from Human Resources to Interior Design to Policy Studies.

A partial list of those principles, as articulated in the idiom of Western scholarship, would be: One: even with advanced technological tools, humans necessarily inhabit a space *between* determinism and randomness. In any open system, there will be chaotic features; Two: At the human level of scale, the universe is necessarily probabilistic. To put it in the language of climatology, the universe exhibits nonlinear forms of causality in irreversible time; Three: nonlinearity in irreversible time means that there are always unintended consequences to any human intervention, what in the West are traditionally called "accidents," "Butterfly effects," "Black Swans," "glitches," "bugs," "system noise," "unknown unknowns," etc.; Four: the stubborn fact of the unintended consequence demands an appropriate response in terms of how we *do* knowledge. It demands a response that requires us to chart a path between extreme determinism and acausal absurdity. Nobel-prize winning Belgian Chemist Ilya Prigogine (1996) described this response perfectly: "the initial conditions of a single trajectory correspond to an infinite set…but in the real world, we can only look through a finite window" (p. 101). There is simply no way to ever anticipate all consequences, and no amount of improved knowledge or technology will ever erase this stubborn epistemological fact; Five: Not only is it impossible to anticipate all consequences, it is also impossible to anticipate with finality whether those unexpected consequences will be good or bad, since they are assigned value in their local contexts, and those local contexts are themselves nonlinear systems. What was once an adaptive output can become a maladaptive input, as its system evolves. What was beneficial in one context might be inadequate or harmful in another. Indeed, often what even *counts* as beneficial depends on who is assigning the value, and why, and when, and for whom.

Sometimes, then, it's difficult to make a permanent judgment as to which consequences are toxic and which are adaptive. An evolving and interdependent universe is one in which the valence of the unexpected consequence is relative, since nothing can be gained in one domain without loss in another, and even the transition from gain to loss or loss to gain cannot always be predicted accurately.

A good example of the difficult prediction and the flipping value is the well-meaning global attempt to go paperless in order to reduce waste. What has actually happened is that through a series of unintended consequences—cascading through interdependent systems of overproduction, poor planning, deregulation, and of course simple human greed and selfishness—digital waste has disappeared into our dutiful recycling and donation policies, only to re-appear in the poisonous wastelands of smoking e-waste, in the ersatz grey economies of places like Ghana.

The tangled ways in which science, technology and capitalism create suffering at the margins is beyond the scope of this paper. However, the example is instructive: despite our now-long history of theorizing nonlinearity, we in the West still tend to acknowledge interdependence when we feel it's to our advantage, and to ignore it otherwise. Part of this convenient approach is to talk about interdependence at abstracted macro-levels, neglecting how deeply

specific unexpected consequences tend to cascade through time at increasingly finer levels of scale, with increasingly singular and differential qualities.

What is often missing in these abstracted definitions of interdependence is the acknowledgement and understanding that unexpected consequences are experienced locally, downstream, from highly particular standpoints that are rarely captured fully by the overall framework. Indeed, such standpoints often cannot be captured in principle, simply because the qualities of nonlinear interdependence are magnified at increasingly fine levels of scale.

But what do we mean here by "levels of scale"?

A useful explanation, or at least heuristic, comes from Benoit Mandelbrot, the inventor of Fractal Geometry. Mandelbrot (1967) asks a famous question: How long is the coast of Britain? It turns out that, in contemporary geometry, the answer is always "depends." Depends on your standpoint. Depends on your goal. Depends on your rationale. Depends on the relative level of scale you're looking at and looking from.

As Mandelbrot points out, geographical surfaces like coastlines have features that recur across levels of scale, such that their lengths, when measured, become so rich in detail that they are "often infinite, or more accurately, indefinable," so much so that we need to consider the quality of *dimension* as a "continuous quantity that ranges from 0 to infinity" (p. 636). In other words, coastlines and other seacoast shapes exhibit squiggles within squiggles within squiggles, and with each new level of squiggle measured, the "length" of the coast increases. As a practical measure, then, it becomes necessary to designate the scale at which one stops measuring, in order that one can arrive at a determinate measurement at all.

This is no spooky mathematics; as humans navigating the mesocosm, we set semi-arbitrary limits all the time as a matter of pragmatics, even survival. A dentist doesn't need to map the tiny whorls and indentations of a mouthful of teeth in order to extract one of them; a dentist does, on the other hand, need a higher-resolution map of teeth in order to fill one, and higher yet to crown one if the overall bite of the patient is to stay sound. The price for an acknowledgement of scale, then, is that there are fewer handy generalizations that apply in all circumstances: the map must fit the purpose and the circumstances.

We might call this acknowledgment of scale *relativity*, as distinct from *relativism.* Four points that follow from Mandelbrot's coastline example will explain. First, the length of a coastline cannot simply be anything we want it to be: it is constrained by the stubborn facts of physics. Second, the length of the coastline as we *perceive it* is dependent on how we measure it. Third, how we measure it is dependent on our standpoint, where we measure *from*. Finally, the standpoint we take and the scale we set are dependent on our goals and our rationales.

So, for example, if one wants to create a national map of all Britain, the scale of the coastline will be relatively course. If one wants to build a seaside house in Cornwall, and make sure the foundation is secure, one will set the scale of the coastline at a much finer scale. If one wants to count the population and position of juvenile hairy crabs within a small section of seashore, the scale will be very fine indeed. In each successive case, the increase in "squiggles" means a net increase in length.

We could also say it means a net increase in complexity, and conjecture that each level of more finely-grained scale is a net increase in "truth" or "accuracy." An implication would be that some projects require less "truth" than others, but we are not interested in that epistemological and pragmatist set of arguments here, interesting though they are.

So what does fractal scale have to do with interdependence? How does scale apply to policy, education, and knowledge, as those domains confront interdependence? Policy decisions might benefit from a simple and practical combination of cognitive tools: the heuristic power of the fractal with the stubborn fact of nonlinearity. In such a combination, nonlinearity itself could be seen to get more "squiggly" at finer levels of scale, with more sinuous, tortuous, nested and undulatory levels of time and space, more granular and pixilated causal webs.

If we take Mandelbrot's coastline example, we might say that the "squiggliness" of a coastline is a heuristic metaphor or analogy for—or maybe even an example *of*—the complexity of a system. In all cases that we can think of, the finer the scale, the more complexity is visible. Secondly, the more the complexity, the more there are notable elements of randomness and unpredictability, since one is now taking into account more finely grained local variables. The more local variables one has to take into account, the less one can map out a durable paradigm or scheme that is abstracted *from* the local; moreover, the less one can map out a durable paradigm, the less portable that paradigm becomes, and the fewer cases it can anticipate, diagnose, manage, and understand.

A scale-dependent model for interdependence would have specific implications. We would have to acknowledge, then work with, the fact that maps or systems of knowledge at fairly course levels of scale will not predict as accurately how singular, local systems will behave, since such maps or knowledges by definition would be accounting for many fewer variables. Thus, they would be less "accurate," but more generalizable, and easier to apply, teach, and implement. Maps or systems of knowledge at fine levels of scale, on the other hand, would predict more accurately how singular systems will behave, since they by definition are accounting for more variables, but be less generalizable, and more difficult to apply, teach, and implement. In each case there are significant cost-benefit decisions to be made.

Further, it may be the case that knowledge at different levels of scale is differently *available*, depending on the situation. Finer and more granular levels of scale may yield more *types* of information, in addition to more *volume* of the information already available, and understandable at cruder levels of scale.

In 1990, Queer Theorist Eve Sedgwick (2008) introduced the concept of the "nonce taxonomy" in *The Epistemology of the Closet* (p. 23). The nonce taxonomy is a map or paradigm that is *sui generis*, single-use, ad hoc, extemporaneous, emergent, and extremely context-sensitive. Sedgwick describes the practice of nonce taxonomies as incredibly scale-dependent, not to mention labour intensive. Since nonce taxonomies are always local, they can be more "accurate," but they are by definition hard to generalize, and nearly impossible to codify; they are by nature difficult to apply, teach, and enshrine in pedagogical, legal, or policy documents.

However, as a process-relational thinker, Sedgwick is also at pains throughout *The Epistemology of the Closet* to demonstrate that nonce taxonomies, in all their ephemerality, are not isolated things, but rather examples of onflow in a process-relational world. To regard nonce taxonomies as temporary isolates would be simply to default to the Western habit of substantialism. Instead, Sedgwick argues that nonce taxonomies partake of and are dependent upon—indeed, are scavenged from and recombinations of—other taxonomies, nonce and otherwise, all of which have come before, all of which arise and pass away in mutual dependence. This epistemological and ontological commitment requires the "making and unmaking and remaking and redissolution of hundreds of old and new categorical imaginings" (p. 23).

Though nonce taxonomies sound difficult and tedious, Sedgwick argues that we use them all the time in everyday life, precisely since they have slippery, yet identifiable, connections to cruder, more abstract, and durable taxonomies.

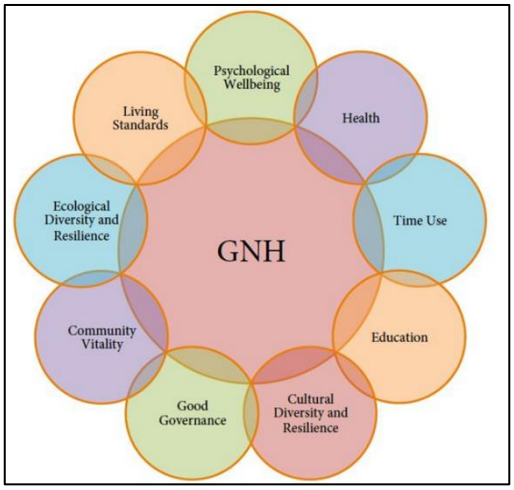
One urgent question for knowledge will always be, then: what is the most practical scale to set in a given situation, given the commitments, goals, ethics, and necessities of a classroom or policy? What is the right balance between accuracy and pragmatism? Any teacher or policymaker knows this challenge in their bones, since part of good teaching or policy is to find the equipoise between breadth and depth. [2]

Interdependence, Scale and Policy

While knowing the challenge of finding the most practical level of scale to balance accuracy and pragmatism may be known in one's bones, doing so practically must wrestle with the inevitable unpredictability of interdependencies at different scales. The formulation and implementation of policy, for example, is particularly susceptible to different interdependencies perceived at different levels of scale. Policy formulation, the macro-level of scale that often relies on generalized knowledge for broad application, contrasts with the experience of policy implementation, the finer, local level of scale, where the policy is put in action in different localities where contextual knowledge and deeper, unexpected interdependencies may emerge. The eastern Himalayan country of Bhutan offers a useful case to explore the implications of this situation. Perhaps more than most countries, Bhutan recognizes the inherent interdependence that weaves through social, economic, and ecological systems that needs to be accounted for in the process of both policy formulation and implementation. This is reflected in the country's distinctive development model known as Gross National Happiness (GNH). GNH conceptualizes development as incorporating interrelated social, cultural, economic, ecological and governance dimensions. Cultivating these dimensions through policy creates the enabling conditions for individual and collective happiness as the end goal of development. Happiness in this sense is understood as a harmonious balance between material wellbeing and the ecological, spiritual, and cultural aspects of an individual and society. GNH therefore constructs development as a vehicle to foster the multiple dimensions of being human. Critically, GNH is indigenized through its foundation in Bhutanese cultural values. These values emphasize balance, dignity, harmony, sustainability, interdependence among sentient beings, and the sanctity of all life (Givel, 2015; Priesner, 2004; Rinzin et al., 2007; Tashi, 2004, Tideman, 2011).

The original conception of GNH incorporated four interrelated pillars that draw upon GNH's foundational values: equitable socio-economic development, environmental sustainability, cultural preservation and promotion, and good governance. The promotion of these pillars through policy provides the pathway to creating the enabling conditions for happiness. These four pillars of GNH were more recently expanded into nine interrelated domains.

Figure 1: The nine domains of Gross National Happiness (GNH)



Source: Oxford Poverty and Human Development Initiative, (2023).

Implementing GNH requires attention be paid to the interdependence of the domains and their interactions with one another (Rinzin, 2006, p. 30). Effectively balancing the domains so they engage with one another rather than compete with one another is central to successful GNH policy formulation and implementation. In this context, Bhutan has developed policy tools to practically implement GNH. These tools require policymakers to respond to interdependence. A GNH Index was created to measure policy outcomes based on the nine domains of GNH as a vehicle to inform policy formulation (Ura et al., 2012). A national survey is undertaken approximately every five years using the GNH index. A GNH policy screening tool is used in the policy formulation process itself. It requires a group of policy stakeholders to assess a proposed policy and its potential impacts across the GNH domains. For example, the tool would require a draft mining policy to be assessed not only in terms of its potential economic and environmental impacts, but its implications for Bhutanese culture, psychological wellbeing, community vitality, health, etc. The tool is quantitative in nature and an inability to reach a required threshold means the proposed policy must go back to the drawing board (Penjore, 2008).

Bhutan's GNH model and its accompanying policy tools represent a meaningful approach to engaging with interdependence directly in the policy process. Yet, as our previous discussion argues, understanding interdependence at different levels of scale means accepting that the available knowledge and degree of complexity will be different at these different levels of scale. For the policy process, this means that policy formulation – the macro, more course level of scale – is rooted in more general, potentially less accurate knowledge accounting for fewer variables that is required for generalizability. In contrast, the policy implementation process where policy is applied in multiple local contexts – the local, finer level of scale – exists within more and potentially different knowledge in a specific local context that is characterized by more variables. The implication is clear: a policy formulated at the macro-level of scale in order to be generalizable will be confronted by the greater complexity and the greater potential for unexpected consequences when it is implemented at the local level of scale. Even when policy formulation tools exist to engage with interdependence, as is the case in Bhutan, deeper interdependencies at the local level potentially introduce new local variables that can

generate adaptations or maladaptations that cannot be planned for at the macro-level of policy formulation.

Human Wildlife Conflict Policy in Bhutan

The policy challenge that characterizes the nature of interdependence and the interplay between different levels of scale can be illustrated in Bhutan's experience with human wildlife conflict (HWC). The World Wildlife Fund (WWF) defines HWC as "encounters between humans and wildlife that lead to negative results, such as loss of property, livelihoods and even life" (WWF, 2023). It is most prevalent in agricultural settings where wildlife have easy access to food through eating crops and predating livestock or where wildlife are destroyed through retaliatory killings by farmers. It is a conflict that often emerges from the perceived competing demands between rural livelihoods and wildlife conservation. Research from multiple country contexts illustrates that HCW can lead to large income losses among farmers, widespread death of animals, the transformation of wild habitat, significant financial outlays from governments to address the problem, and, ultimately, the creation of a political problem that pits humans or institutions against one another (Choudhury, 2004; Hill, 2004; Mekonen, 2020; Karanth and Madhusudan, 2002; K.C., Min and Serenari, 2022; Treves and Naughton-Treves, 1999; Treves et al., 2006).

The nature of HWC in Bhutan can be understood in terms of the challenge of balancing interdependent GNH domains. In particular, the challenge of balancing the demands of conservation (the ecological diversity domain) and rural livelihoods (the living standards domain). On the one hand, while Bhutan's economy is changing, 49% of the labour force continues to work in the agriculture, forestry, and fishing sector (Ministry of Education & Skills Development, 2023). The dominance of such rural livelihoods is paralleled by Bhutan's significant record of conservation. Seventy-one percent of the country is currently forested and over half of it is protected through a series of national parks, wildlife sanctuaries and biological corridors (Forest Resources Management Division, 2016). Within this vast area of forests and protected areas, Bhutan is home to over 7,000 species of vascular plants, 770 species of birds and 200 species of mammals, a number of which, such as the snow leopard, are threatened globally (Wildlife Conservation Division, 2010). Given this diversity, Bhutan is recognized as part of one of the world's biodiversity hotspots (Banerjee and Bandopadhyay, 2016).

Bhutan's successful conservation record is rooted in a meaningful enabling environment through a strong legal and policy framework. Perhaps unique in the world, Article 5(3) of Bhutan's constitution requires 60% of the country to be forested in perpetuity. The country's current status of 71% forested land can therefore never fall below this directive in the constitution. Stringent wildlife protection legislation and regulations accompany the legal framework for forests. The *Forest and Nature Conservation Act 1995 (Bhutan)* outlines the legal framework for wildlife protection. Twenty-three kinds of wild animals, including large predators, are designated as "totally protected". These animals cannot be killed or captured unless there is an imminent threat to human life. In addition, only non-lethal methods that scare these animals can be used to protect from attacks on livestock or crops. All other wild animals are designated as "protected". They can only be killed or captured when there is an imminent attack on humans or livestock, or to defend against crop damage while on private land. If a protected animal is killed on private land while damaging crops, no legal action is taken if the animal dies on the farmland or within 200 metres of it. Anything killed beyond 200 metres is prohibited. It should be noted that the *Forest and Nature Conservation Bill of Bhutan 2021* was introduced

to update the 1995 legislation. It was not yet passed at the time of writing. The circulated version of the Bill nonetheless generally maintains the wildlife conservation provisions of the 1995 legislation.

The legal and policy framework that has framed Bhutan's conservation success rests on a particular value foundation. Not surprisingly, it is the same value foundation that underlies Bhutan's GNH model as a whole. Balance, dignity, harmony, sustainability, interdependence among sentient beings, and the sanctity of all life are values that all point to how humans should co-exist with animals, and they form the bedrock for conservation policy.

The apparent success of Bhutan's conservation record masks a more complex situation. As the GNH framework recognizes, conservation has an interdependent link to rural livelihoods where 49% of the workforce are active. This interdependence has led to an emergent outcome. The success of conservation policy has resulted in vast areas of forested and protected land inhabited by lots of wild animals. This situation encroaches on farmland. Flourishing numbers of animals have increasingly easy access to crops and livestock. The protection these animals receive through conservation policy significantly limits the ways farmers can respond. As a result, successful conservation policy has led to Bhutan experiencing a real problem with HWC. Wild pigs, monkeys, and deer destroy crops, sometimes wiping out a farming family's entire annual crop in a single night. Elephants in the south of the country also destroy crops and, in some cases, homes. Tigers, bears, and leopard kill livestock and, on occasion, humans. The extent of the problem is significant. While accurate numbers of incidences of HWC nationally are hard to come by, figures reported in a recent study show that 70% of farmers reported crop destruction and 12% reported livestock losses, representing an incidence rate of HWC that is four times higher than experienced in the United States and the European Union (Tshewang, Tobias, & Morrison, 2021). Bhutan's success with conservation has therefore led to a significant threat to rural livelihoods. A negative interdependent relationship exists despite the intentions of the GNH framework.

HWC Policy Formulation: The Macro Level of Scale

Drawing on its GNH approach of balancing domains, the Royal Government of Bhutan (RGoB) engaged in a policy response to HWC that recognizes the negative interdependence at the heart of the issue. Multiple government documents have identified the issue of negative interdependence between rural livelihoods and conservation driven by the success of the latter. The formulation of policy represents a response to this issue at the macro-level of scale. The central government defines a policy intention and subsequently formulates policy based on big picture knowledge at the national level. In our coastline analogy, this is the equivalent of making a national map of the coastline of Britain. In the case of HWC in Bhutan, the formulation of policy is most clearly outlined in the *Bhutan National Human-wildlife Conflicts Management Strategy* (Nature Conservation Division, 2008). At this macro-level of policy response, the RGoB not only recognized the negative interdependence that has emerged between rural livelihoods and conservation, it provided a response that promotes positive interdependence. The strategy provides multiple activities that work together to decrease incidences of HWC while simultaneously strengthening both rural livelihoods and conservation. An interdependent and virtuous circle is the intent. Key activities include:

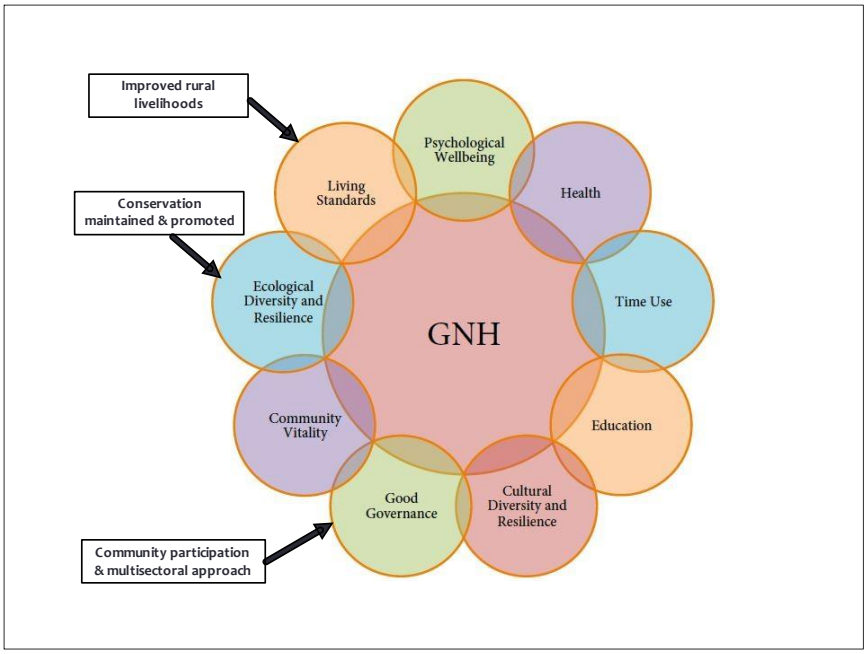
i) HWC mitigation: installation of fencing, alarms, and visual repellants to protect crops from wildlife and promote conservation by preventing retaliatory killing of wildlife.

ii) Agricultural intensification: enhance production and mechanization of agricultural practices to improve crop yields to decrease or counterbalance crop losses from wildlife.
iii) Livestock intensification: promote improved cattle breeds that are stall fed to increase milk production and decrease predation experienced by traditional cattle that graze in the forest.
iv) Alternative incomes: promote new rural livelihood opportunities based on conservation, such as eco-tourism and non-wood forest products.
v) Continued enforcement of conservation regulations: issue fines for illegal retaliatory wildlife killings and promote zero poaching.
vi) Insurance: provide crop and livestock insurance for HWC losses.
vii) HWC governance: recognize the interdependent nature of HWC by engaging a multisectoral approach to policy implementation involving multiple departments and multiple levels of government, with an emphasis on fostering local participation.

The macro scale policy response from the RGoB therefore links conservation and rural livelihoods as two interdependent and inseparable components that work together to mutually strengthen one another. Mitigation activities seek to both protect crops and maintain conservation. Rural livelihood activities intend to enhance income opportunities through better agricultural practices that decrease the threat of HWC and through alternative incomes based on conservation. Both of these occur in the context of maintaining the historically strong focus on conservation regulations with insurance opportunities provided for income support in cases of HWC losses. A multisectoral and multilevel governance framework implements the policy to better ensure an attentive approach to the interdependent nature of both the problem and the policy response.

The virtuous circle driven by the integrated nature of the HWC policy response fits nicely within Bhutan's holistic GNH development model. Improving rural livelihoods contributes to the *living standards* domain of GNH. Maintaining and strengthening conservation contributes to the *ecological diversity and resilience* domain. Engaging community participation and a multisectoral government approach in the implementation of the policy promotes the *good governance* domain.

Figure 2: Macro-level of scale: Intended positive impacts on GNH of human-wildlife conflict policy formulation



The formulation of the HWC policy based on its underlying assumption of negative interdependence as the core of the problem and fostering positive interdependence as the solution provides a macro-level policy response formulated for application nationally. Exploring the local scale of implementing the policy on the ground in multiple local contexts, however, illustrates how the nature of interdependence evolves between levels of scale with implications for policy success. The coastline's relatively course nature as seen from the macro-level, like when drawing a national map, becomes infinitely more complex and detailed at the local level when standing directly on it searching for juvenile hairy crabs.

HWC Policy Implementation: The Local Level of Scale

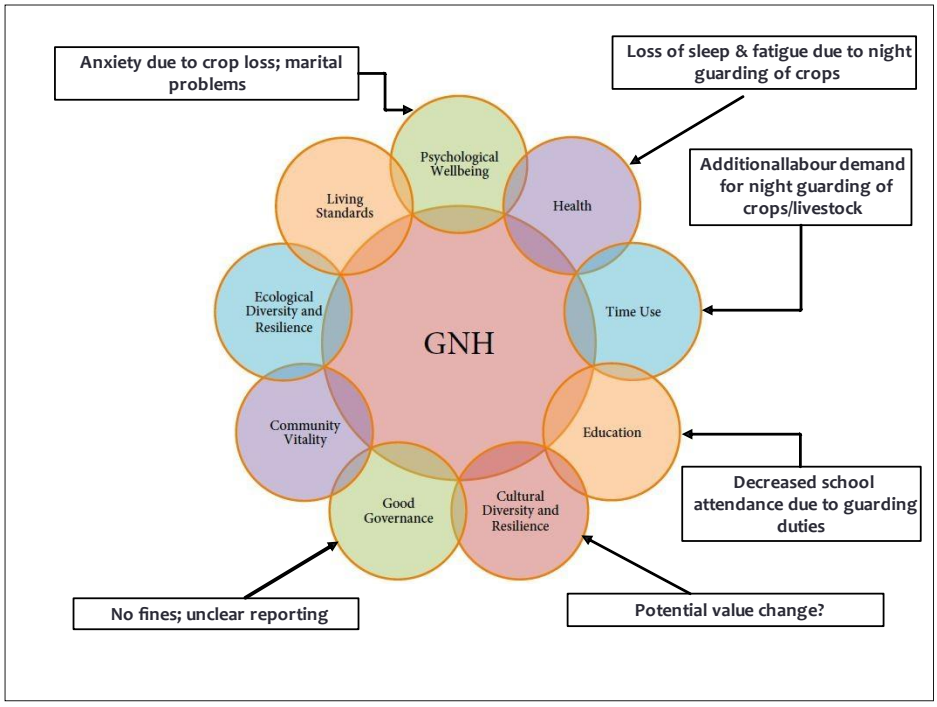
Assessing whether the outcomes of HWC policy implementation at the local level of scale reflect the policy intentions of the macro-level of policy formulation illustrates a mixed degree of success: conservation of wildlife largely remains strong, HWC mitigation strategies such as fencing have had visible effect in some locations but not others, insurance schemes provide a safety net for some farmers although are characterized by frequent delays and poor communication, and improvements in rural livelihoods have occurred in areas such as livestock rearing and ecotourism, although the latter's success differs across regions (Schroeder, 2018, ch. 7).

Such mixed success is not surprising. Original policy intentions of the policy formulation process are always subject to changes in the application of policy implementation (Elmore, 1979; Lipsky, 1980; Morah, 1996; Prottas, 1979; Ridde, 2009). Overall, though, Bhutan's HWC policy outcomes suggest that the assumption underlying the policy formulation process has some merit. Policy outcomes, as outlined above, reflect to a degree the notion of a positive interdependent relationship between promoting conservation while fostering improved and

new rural livelihood activities. But a closer analysis of the local level illustrates that the implementation of HWC at a finer level of scale is characterized by deeper interdependencies not identified at the macro level during the policy formulation process. The positive interdependence between conservation and livelihoods is nested in a more complex set of deeper interdependencies that drive other, sometimes unexpected, outcomes at the local level. In the case of HWC policy, these additional outcomes reflect negative relations of interdependence that work against the overall success of the policy and, more broadly, detract from fostering GNH.

Using the lens of GNH to analyze the deeper interdependencies at the local level of the HWC policy implementation process is a useful way to understand how these interdependencies not only complicate HWC, but interact with other development domains in often unexpected ways. Figure 3 provides an overview of the adverse and unexpected HWC interdependencies visible at the local level and their connections to specific GNH domains.

Figure 3: Local level of scale: Actual adverse impacts on GNH of human-wildlife conflict policy implementation



Sources: adapted from Schroeder, 2018 and Yeshey et al., 2022.

The following explores the outcomes at the local level of scale in terms of individual GNH domains, with a further focus on the interdependence and resulting feedback that occurs across these domains. The data used in this analysis are primarily drawn from semi-structured interviews with 96 HWC stakeholders. These interviews were part of a larger 2018 study on the implementation of GNH policies at the local level (Schroeder, 2018). Where relevant, other research is also drawn upon.

1) *Time use domain*: The GNH domain of time use represents the importance to individual wellbeing of the balance between paid work, unpaid work, and leisure time. The formulation of HWC policy did not explicitly address this domain. The policy's focus is on fostering the interdependence of conservation and rural livelihoods to improve both. Yet the mixed success in doing so has had implications for the time use of some farmers. The mitigation strategies of the HWC policy, including fences and alarms meant to scare off animals, have had success for some individual local areas yet have generated problems in other localities. Electric fences, for example, often show significant success in keeping wildlife out of agricultural fields. Yet animals also adapt, simply relocating to other localities and continuing to destroy unprotected crops where fences do not exist. In many cases, these fences do not exist given cost or lack of communication on their availability. Even in cases where fences do exist, some animals like macaques adapt their behaviour to circumvent the effectiveness of the fences. In the case of alarms, wildlife further adapt by getting used to the sound, which no longer scares them off.

As wildlife adapt to alarms and fences or move to unfenced farmland, the consequence is the need for many farmers to stay up at night in guard huts in order to scare away wildlife. Farmers work in the fields all day and are then forced to stay up at night to guard them. As a domain of GNH, the time use of farmers is negatively affected. While this is not a situation newly generated by the HWC policy, the policy is embedded in it and interacts with it, creating a new situation where wildlife have adapted to the policy activities. The need to guard therefore continues despite the policy. Formulation of the policy at the macro-level did not effectively identify this situation and the local scale of policy implementation was not able to prevent it as the situation evolved differently in different local contexts: some finding success with HWC mitigation strategies, but with that success leading to animals simply adapting or relocating to unprotected localities.

2) *Health domain*: The negative consequences on the domain of time use feeds back onto other GNH domains as the challenge of wildlife adapting to the HWC mitigation strategies has a compounding effect. Wildlife adapt to fences and alarms in some localities, forcing some farmers to guard their crops at night leading to poor work life balance, which in turn leads to fatigue and poor health among farmers. The necessity to abandon appropriate time use therefore drives further negative consequences in the GNH domain of health.

3) *Psychological wellbeing domain*: The psychological wellbeing domain focuses on life satisfaction, positive emotions, and spirituality. Poor time use and poor health driven by patchwork local success of the HWC policy also negatively affects farmers' psychological wellbeing. As wildlife adapt and circumvent the impact of fences and alarms put in place by the policy, the need for some farmers to continue to guard at night and the accompanying negative impacts on time use and health creates anxiety and negative emotions. This is not surprising given the worry over losing crops or livestock and the need to lose sleep to guard them. Yet the nature of anxiety goes deeper, including contributing to marital problems within farm families. In essence, interdependencies visible at the local level show that the success of Bhutan's conservation policy, combined with only mixed success of HWC policy, has contributed to marital breakdown. Again, this was not a consequence seen or understood at the macro-level scale of policy formulation. Other research has found similar findings as poor psychological wellbeing was found to be the most frequent indirect impact reported by farmers (Yeshey et al., 2022).

4) *Education domain*: Negative interdependencies rooted in the insufficient success of the mitigation strategies of the HWC policy go even further. The lack of sleep, anxiety and potentially poor health experienced by farmers driven by the need to guard crops means that some farm families choose to have their children do the guarding at night. This allows farmers to get enough sleep to work effectively during the day. The result, however, is tired children who miss school after a long night of guarding.

The mixed success of HWC policy's mitigation strategies has therefore fed back and interacted in negative ways with multiple conditions, including the GNH domains of time use, health, psychological wellbeing, and education. The intention at the macro-level of policy formulation that promoted the GNH domains of living standards and ecological diversity by fostering a positive relationship of interdependence between them has evolved at the local level and negatively impacted four other domains of GNH. Many farmers' lives have been negatively impacted as a result.

5) *Good governance domain*: The unexpected outcomes driven by interdependencies evident at the local level not only directly affect farmers. The good governance domain of GNH emphasizes effective government performance and political participation. The implementation of HWC policy at the local level of scale illustrates two issues related to good governance. First, a key part of the original HWC policy intention is strong conservation, which is intended to further strengthen livelihoods. A central component of the HWC policy is therefore to maintain strong enforcement of conservation rules and regulations. This includes fining farmers for illegal retaliatory killing of wildlife. Yet, the web of HWC interdependencies visible at the local level that leave some farm families with destroyed crops, poor time use, poorer health, decreased psychological wellbeing, and missed education opportunities have further interacted with the actions of government officials charged with conservation enforcement. Some of these officials report that, rather than issuing fines when confronted with cases of retaliatory killing of wildlife, they simply look the other way. They know this is wrong, but they take pity on farmers whose livelihoods and individual wellbeing continues to be affected by HWC despite the policy. Empathy for farmers overtakes the need to fulfill the requirements of their job as directed by the policy. While this does not appear to be widespread, it represents a potential threat to conservation efforts, a pillar of the HWC policy, as some government officials purposefully overlook enforcing regulations.

The second issue related to the local implementation of the policy and its connection to the good governance domain of GNH has even broader implications. The HWC policy is embedded in a governance structure that involves multiple levels of government implementing the policy. While the central government designed the policy, it is partnered with local governments at the dzongkhag (district) and gewog (village block) levels in implementing the policy on the ground. Moreover, at the central government level, multiple departments (Agriculture, Forests & Park Services, Livestock) are involved. Given the complicated structure and relationships across these levels of government, combined with the multisectoral nature of the HWC issue, the reporting of cases of crop or livestock destruction by wildlife has become inconsistent at different localities. The policy itself is therefore embedded in a governance reporting structure that is confusing, undermining the very knowledge needed to understand and effectively respond to HWC.

Interviews with officials within this HWC governance framework illustrate the depth of this confusion. In many cases, it is the gups, or village leaders at the gewog level, who are adamant

that they are responsible for reporting crop destruction up the line to the appropriate central government ministry. In other cases, Renewable Natural Resources (RNR) staff, such as Agriculture Extension Officers, Forest Extension Officers, and Livestock Extension Officers, who are dzongkhag administration officials that work at the gewog level, claim they are responsible for reporting. Yet there are disagreements among themselves over who is responsible based on whether the incidence of HWC is related to crops or livestock. There are further disagreements over who to report to up the line. In still other cases, District Agriculture Officers, or District Forest Officers at the dzongkhag level claim that they are responsible for local reporting. Adding to the confusion are some Territorial Forest Officers, who are central government staff, who also claim to be responsible for reporting HWC. Embedding the implementation of the HWC policy in a governance structure intended to address the multisectoral nature of the HWC issue, an appropriate approach to a complex problem, has ultimately interacted on the ground with the nature of this structure in a way that has generated reporting confusion. The overall result: inconsistent reporting and poor data on HWC across different localities, resulting in poor national data.

Different Levels of Scale and Emerging Ambiguity

At the macro-level of scale, the formulation of HWC policy was based on the assumption that there is a negative relationship of interdependence between conservation and rural livelihoods and that addressing this issue could be done by fostering a positive interdependent relationship between them. Policy outcomes illustrate some success in this. But at the local level of scale, the implementation of the HWC policy evidenced a deeper set of interdependencies accompanying or emerging from the policy that negatively contributed to some farmers' time use, health, psychological wellbeing, and education. This situation drives some officials tasked with enforcing conservation rules to not do so given the sense of pity they have for farmers. All of this is underlain by a governance structure that has confused the reporting of incidences of HWC. The nature of interdependence assumed at the macro-level is therefore only a course-grained, partial picture of the much deeper nature of interdependence visible at the local level of scale.

This is already a challenge for the long-term success of the HWC policy. Yet it all drives a further unexpected outcome that is particularly problematic. The multiple negative interdependencies experienced by farmers combined with the poor HWC data that emerges from the reporting structure have resulted in different HWC stakeholders developing diametrically opposed assumptions on the very nature of the interdependencies at the heart of the HWC problem. The macro-level policy intention was rooted in a clear assumption about the nature of the interdependent relationship between conservation and livelihoods: past strong conservation practice drove increased HWC that hurt rural livelihoods. Expanding forests with expanding numbers of animals encroached on agricultural land and provide easy food for wildlife. The experience of implementing the resulting HWC policy at the local level of scale, however, has resulted in this assumption now being riddled with emerging ambiguity as stakeholders disagree on the very nature of interdependence.

On the one hand, for many HWC stakeholders, the experience at the local level of policy implementation has confirmed this foundational assumption with the additional knowledge that multiple deeper interdependencies are also visible at the local level. On the other hand, another set of stakeholders take a competing view on the nature of the interdependent relationship that shaped the original policy formulation at the macro-level. They now reject the

original assumption of the policy and propose an opposing one. For these stakeholders the confusion driven by the poor data that emerged from the HWC reporting structure has led to a reconceptualization of the cause of HWC. For them, the successful conservation of forests and wildlife has not led to increased encroachment by animals on farmland; rather, expanding rural agriculture activities, including through the HWC policy, has encroached on forests and wildlife. HWC is therefore driven by expanding rural livelihoods, not by successful conservation. The negative interdependent relationship at the heart of the HWC problem remains, but the direction of influence is reversed. Contributing further ambiguity on the cause of HWC is the view of still other stakeholders who believe expanding rural livelihoods *and* successful conservation are both concurrently at fault for the problem. The tangle of interdependence that emerges at the local level and the accompanying poor reporting of HWC, which were not evident issues at the macro-level of policy formulation, have therefore led to the assumption underlying the HWC policy itself to be contested. The challenge of effectively responding to HWC is infinitely more difficult if the cause of the problem is no longer agreed upon by those charged with implementing the policy.

Policy implementation officials contesting the underlying assumption of the HWC policy is a significant problem for successful implementation of the policy. But an even deeper and more profound problem is also evident. For a small sub-set of government officials, the negative interdependencies evident at the local level have contributed to a surprising shift in perspective. The depth of challenges that these negative interdependencies create for farmers has led these stakeholders to now question the very value that is a bedrock of the HWC policy and of Bhutanese society at large. They believe that there is a need to move beyond holding fast to valuing the sanctity of all life. For these stakeholders, more widespread retaliatory killing of wildlife should be allowed to protect rural livelihoods. This perspective essentially holds that there is a need to sever the pursuit of a positive interdependent relationship between conservation and rural livelihoods. For these stakeholders, the tangle of interdependencies that emerge at the local scale necessitates abandoning a bedrock value. The result: the intentions of the HWC policy at the macro-level would be completely undermined.

Overall, a challenging and curious policy situation unearthed at the local scale therefore exists, a challenge that was not intended nor expected when viewed at the macro-level of policy formulation. A HWC policy that has had some mixed success is nonetheless characterized by multiple unintended consequences visible at the local scale driven by interdependencies. These consequences have led policy stakeholders to dispute the underlying assumption of the policy itself creating ambiguity on the problem's origin. In rare cases, some stakeholders have moved further and rejected the bedrock value that frames the policy. A clear approach to a problem conceptualized at the macro-level of scale is now, as a result of the interdependencies apparent at the local level of scale, ambiguous and contested.

Conclusion

The Bhutanese case of HWC policy demonstrates the practical challenge of setting a scale that will balance generalizability with local context, given the different interdependencies perceptible at different levels of scale. What might it mean, then, to set the scale for understanding interdependence, and perhaps for mitigating some of the possible consequences that are missed when the scale is set too high, and the resolution too crudely?

There are at least three types of scale when understanding a complex system. The first is the scale of time: How fine are the units of duration or persistence? How fine is the rate of change? The second is the scale of the actors or elements: how finely textured and granular are the variables, and how many are there? The third is the scale of scope: How local is the system under analysis? How fully influenced is it by local variables?

Because interdependence has special properties, the implications of scale are especially pressing. Namely, the input of minute, local variables can completely skew the more portable, more generalizable, maps of knowledge that are meant to account for a multiplicity and variety of local systems, when those local systems appear to be similar or identical at a courser level of scale.

The very premise of the famous Butterfly Effect—which demonstrates extreme sensitivity to initial conditions—is that infinitesimal variables at the local level sometimes have massive affects that can be seen and felt even at the coarsest levels of scale. The implications for knowledge are severe, in that the map or explanation of the effects either cannot be constructed at all, or—at best—can only be constructed after the fact. It is important to note that the butterfly does not cause the hurricane by itself, but is an indispensable element from the set of original conditions for an interdependent system set in irreversible time. There is no way to co-opt or adapt the Butterfly Effect for prediction or management. If anything, it is an acknowledgment and embodiment of the limits of knowledge and management.

Once the limits are understood and acknowledged, one ongoing goal for policy and knowledge would be to use what we already know of interdependence to try to better balance abstract and local, general and specific. It would be important to further refine tools that help us set the scale in a pragmatic way, given whatever commitments, aims, and limits are currently relevant. The most important practical aims to identify, early, would be how durable, portable, and generalizable the knowledge or policy needs to be, and how much unpredictability can be tolerated when weighed against that generalizable application. Does the aim of the project require something more, or less, like Sedgwick's nonce taxonomy?

It may even be possible to imagine policy and educational frameworks that include nonce taxonomies within more durable and portable paradigms— the impromptu with the planned; the specific with the abstract; the provisional with the permanent—integrating local and general more deeply. Form and emptiness, perhaps. Such frameworks would necessarily incorporate multiple levels of scale, sometimes seen simultaneously, sometimes seen as nested within each other. Further, the multiple levels of scale would have differential persistence: some would last, some wouldn't. In our understanding, this integration for policy would be more in line with the ways in which interdependence is already understood in maths and sciences—where systems are often seen as an intricate and evolving partnership of chaos and order, signal and noise, entropy and negentropy.

The question, then, is not actually "how long is the coastline of Britain?" The question is "What do we want to do with the measurement of the coastline of Britain?" followed by "what scale, or scales, is appropriate?—how rich, how detailed, how specific, how local?" The answers, for any discrete policy proposal or evaluation, would balance the relative merits and downsides of granular versus coarse knowledge, nonce versus durable taxonomies, within already-existing and pragmatic webs of value.

Notes

1. “West” and “East” are no doubt a dichotomous shorthand, and in some contexts comprise a colonialist distinction; however, when considered from a postcolonial standpoint, where Western stands largely for a "Euro," extractive, and reifying style of capitalism, there is some provisional merit in the dichotomy as a heuristic. There are, of course, "Western" versions of interdependence and scale-sensitive policy in use, but they are in our experience more exceptional than normative, and, as a key point, are driven by longstanding historical traditions where substantialism is at the center of thought. In this light, we believe that a generalized critique of "Western " versions of interdependence can be a pragmatic necessity: even a cursory look at the governance and economies within the range and scope of European traditions demonstrate an endless circulation of noxious externalities, black swans, butterfly effects, frozen accidents, and other unintended consequences, driving the accumulation of environmental degradation and the escalation of social extremes and social stratification, the weaponization of resentment, a persistent designation and derogation of Others, virtualized economies, and the offshoring of whatever is considered toxic or undesirable. These continuing trends reflect a leveraging of unintended consequences into the future, rather than an integration of them into the present, and, as such, index a failure to come to terms with process and relation, and a continuing fidelity to ontologies that separate and quarantine nounlike "items," in order to consider their trajectories independently.
2. Mandelbrot and Sedgwick are, of course, both nominally from the Euro tradition. Might there be better paradigms coming from Bhutanese or Tibetan traditions? Undoubtedly. However, we stick with the Euro tradition here for two primary reasons. One, as stated earlier, there are promising veins of Western process-relational thought, especially following radical thinkers such as mathematician, theoretical physicist, and philosopher Alfred North Whitehead, or, more recently, Bruno Latour and Isabelle Stengers. Second, and more importantly, one of our key claims here is that we are not particularly equipped to capture and migrate the Bhutanese experience, history, ontologies, and epistemologies. That would be to probably misunderstand and misapply their nuances; it would lean dangerously close to capturing and monetizing them; to domesticating them; to infecting them—subtly or otherwise—with substantialist axioms or assumptions. This a clear danger: Bhutanese policy making can't simply be exported out of Bhutan; it is itself deeply historical and context-sensitive. Bhutanese history, and Buddhist logics more generally, may be superior, even *truer,* but to import them would be dangerously close to another act of colonial extraction. We can appreciate and celebrate what we are not yet able to comprehend fully and deeply. We can listen, for now, slowly.

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