CORRESPONDENCE:

Plant breeding capacity building in Africa

To the Editor — Improving food security requires development of farmer-preferred varieties that are more nutritious and adapted to specific agro-ecologies and changing climatic conditions. Challinor *et al.*[1] report that the time from initiating breeding for a trait to adoption of the resulting variety is 18 years, broadly agreeing with other findings that an average age of varieties in use in sub-Saharan Africa (SSA) is 20 years[2] — too long compared to the time frame in which climate models predict varietal characteristics will need to change.

A number of interventions[1] are suggested to improve the effectiveness of investment in varietal development, many of which require significant involvement by practical plant breeders with understanding of the seed business. However, the number of such breeders is limited[3,4]. For example, in 30 SSA countries, the average is about 5 breeders per country to cover all crops, agro-ecological zones, and uses[2]. Therefore, many additional plant breeders are needed in order to avert the impact of climate change on food security in SSA.

In addition to degrees from international higher education institutions, in-region training is needed[5]. In-region training has advantages in cost, relevance, retention, and reduced disruption to family and workplace ties. At the MSc level, two projects funded by the Bill & Melinda Gates Foundation, 'Improved MSc in cultivar development for Africa' (IMCDA), implemented by Alliance for a Green Revolution in Africa, and 'Plant breeding e-learning in Africa' implemented by Iowa State University, USA, involve three pilot universities: Makerere University (Uganda), Kwame-Nkrumah University of Science and Technology (Ghana), and the University of KwaZulu-Natal (South Africa). These collaborative projects focus on core competencies needed by industry-ready plant breeders, targeting increased rates of genetic gain by using modern tools: genomics, molecular markers, electronic data collection, data management and breeding pipeline optimization. Training activities and e-learning resources emphasize the application of scientific knowledge to decision making in plant breeding. Students experience best practices in a breeding programme embedded in the training and through internships and links with progressive, efficient cultivar-development programs. Thesis projects focus on national or regional food security issues of many priority African crops, concentrating on traits such as tolerance to drought, diseases and insects in addition to high yield. Ninety students are expected to graduate from these programmes in the next three years, but this is low compared to the overall needs of SSA countries[5].

Therefore, the throughput of IMCDA and other postgraduate training throughout SSA must be increased. To ensure the sustainability of human capacity development efforts, more investment is needed from governments, development partners and private enterprises. Without such investment, the potential benefits of the proposed interventions[1] will not be realized. To attract and strategically target such investment, there would be great value in involving key stakeholders in SSA to establish a coordinated strategy of capacity development. ❐

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COMMENTARY:

A science of loss

Jon Barnett, Petra Tschakert, Lesley Head and W. Neil Adger

Avoiding losses from climate change requires socially engaged research that explains what people value highly, how climate change imperils these phenomena, and strategies for embracing and managing grief.

Industrialization, land use change, colonization and mobility have effected a step change in the loss of places, populations, social practices and species over the past five hundred years. Climate change threatens to accelerate losses across social and ecological domains, leading the UNFCCC to establish a mechanism to address these potential losses[1]. However, the concept of loss remains poorly theorized and methods to explain it are few[2]. We outline key elements of a science of loss that can better explain how losses arise and help minimize regrettable and irreversible outcomes of climate change.

Loss

Loss arises when people are dispossessed of things that they value, and for which there are no commensurable substitutes. For example, almost all people value their health, personal safety, sense of belonging, esteem, and relative freedom[3]. These are known as the primary goods that are essential for a free and dignified life, and they are the raison d'être of collective action, legal rights, and the state. Climate change amplifies the risk of their loss through many pathways, including increases in water-borne illnesses, damage to housing from extreme events, displacement of communities, and climate-induced poverty traps.

Yet there are many more phenomena that people value that are at risk from climate change, but that are overlooked because they cannot be captured by standard metrics. These include phenomena that constitute the meaning of entire societies, for example landscapes (such as ice fields); places (such as neighbourhoods); cultures (such as those of indigenous peoples); and social cohesion (such as belonging to a community of knowledge or practice). They also include valued phenomena that arise at very fine spatial and temporal scales of experience, for example personal items (such as photographs); material artefacts (such as the graves of ancestors); daily practices (such as gardening); and occupational identities (such as those of farmers and fishers).

When widespread, some losses lead to cascading social and environmental problems. For example, the loss of places, homes and lives due to weather extremes and slow onset processes can in turn cause problems associated with migration, personal safety, resource degradation, and public health and security[4].

Although there are many processes that can ameliorate the effects of dispossession of highly valued material and non-material phenomena, there can be no effective compensation for their loss because they are incommensurable (cannot be compared) with any possible substitutes[5]. This observation is backed by evidence from anthropology, human geography and social psychology[6]. This incommensurability, the likely uneven distribution of losses within and between generations, and the failure of responsible actors to mitigate emissions and facilitate adaption all make the issue of loss a profound ethical problem.

A science of loss

A science of losses arising from climate change therefore requires knowledge of three distinct dimensions: (1) what people value highly, how things come to be valued, and how values vary over space and time; (2) the climatic and social drivers of undesirable changes that put at risk things that people value; and (3) should losses arise, the means and extent to which suffering can in turn be minimized.

What people value. Value formation is not well understood in any discipline despite a diversity of theories, approaches, and methods. Values are constructed through cultural influences and worldviews, narratives that help make sense of places and ways of living, markets and marketing, family and social networks, and people's lived experiences, relationships with nature, memories and aspirations[7].

While there is still much to know about how things come to be valued, there is far more certainty about the nature of valued things and how these vary across space. For example, much recent research from anthropology, geography, and psychology shows that artefacts, heritage, homes, knowledge, places, practices, and social relations are at risk from climate change[8].

Values are 'situated' in specific social contexts in that they are influenced by people's experiences and daily practices, and the places and cultures in which these are embedded. Knowledge of loss therefore requires understanding this situated[9] and inherently subjective nature of values, and how these vary across the diversity of human experiences. Producing such knowledge is a core task for those social sciences able to ground loss in the social and environmental milieu of people's lives, and to ascertain the aspirations of those who stand to lose. It is an exciting science characterized by innovative methodologies, including experimental psychology and economics, ethnographies, participatory methods, methods for understanding how people's bodily experiences and senses influence their cognition, landscape value mapping, mobility mapping, and the use of mobile technologies[10].

Drivers of change. The second element of a science of climate loss is to understand how loss might arise through climate and other associated drivers of change, and how the risk of loss varies across social groups and places. It is now well understood that vulnerability to climate change is as much socially produced through demographic, economic, political and cultural factors as it is a function of changes in climate[11]. These social determinants of vulnerability to climate change are documented across a wide range of risks and contexts, but they are very difficult to factor into attribution models[12]. New forms of spatial analysis promise better integration of social and ecological factors for the purposes of a more integrated understanding of the drivers of loss[13].

Given the challenges of attribution, the science of loss must be cautious. Even in small and supposedly highly vulnerable places, such as atolls, the response of ecosystems to climate change is uncertain and the scope for adaptation to avoid loss is even less well known[14]. Thus, a minimum standard for a science of loss is that it does not claim to predict where and when losses will arise, but rather identifies where, for whom, and why certain losses would be unacceptable and intolerable.

Predictions of loss may themselves contribute to loss. Dramatic narratives about future crises have been shown to influence the risk of crises occurring. Several studies explain how talk of catastrophic climate futures rarely leads to mitigation and adaptation but instead results in fatalism, self-blame, underinvestment in vulnerable places, and even accelerated degradation of natural resources — all of which amplify the drivers that create loss[15]. This situation has parallels in the green paradox where the possibility of fossil fuels depreciating gives signals for increased unsustainable extraction in the present day[16].

Nevertheless, denying the possibility of loss is naive given that the Intended Nationally Determined Contributions (INDCs) under the Paris Agreement fall short of avoiding significant levels of climate change with their associated biophysical and social consequences[17], and there is limited progress on adaptation in vulnerable places. Failure to confront the possibility of loss also contributes to increased anxiety for individuals, and collective paralysis in climate change mitigation and adaptation[18].

The risk that increased emphasis on loss may create perverse incentives can be circumvented by research with, rather than about, the people who stand to lose. In the same way that a science of loss requires situated knowledge about those highly valued aspects of life and well-being that are at risk, it also requires grounded knowledge about desired futures, the contextual drivers of loss, and existing and potential adaptations. This is best done through co-production of knowledge where affected communities and researchers work together to generate knowledge and engage with decision makers. An accurate and practical science of loss must therefore engage with the people and places where loss is likely to be experienced.

Engaging with loss. Though unsettling, embracing the possibility of loss may be the best means of offsetting its harm. Co-produced and situated research with communities where loss is likely can give them ownership of the knowledge of loss and help them to come to terms with it. Such engagement has the potential to stimulate collective responsibility, creativity, and new skills[19]. It can also change expectations of the future in ways that transform perceived losses to something less existentially troubling. For example, anticipatory history approaches that highlight the dynamic nature of the past and link these to dynamic futures have palliative potential through describing and visualizing landscapes as dynamic, transient, and liable to change[20].

There is a long tradition of memorializing places, practices, and peoples who have been lost, and these take diverse forms including films, graves, museums, paintings, photographs, rituals, sculptures, shrines, stories, and songs. These help to manage grief and sustain the association with what would otherwise have been forgotten. A science of loss should therefore combine approaches to anticipate future loss with insights and methods from critical heritage studies, archaeology and museum studies, all of which engage with people's relationships with places, and help them to understand and remember loss[21].

Loss can be planned for better, or ignored for worse. For example, research on community resettlement shows that while resettlement should be avoided, the harms that arise can be minimized given adequate time for consultation and planning, and through practices such as compensating people for economic losses, maintaining community cohesion and social networks, and directing resources to both resettled and host communities[22].

Legal cases where indigenous groups have sought reparations for losses reveal both the incommensurable nature of loss and the limits to legal processes in recognizing and responding to loss[23]. Legal systems tend to interpret loss through the lens of property, which in the case of land not only narrows the scope of the issue, but also leads to decisions that fail to account for the ways of knowing, social relations, forms of identification, cultural practices, and senses of place and community bound in land.

The tragedy of loss underscores the importance of risk aversion in decision-making. In decision theory the risk of irreversible loss is addressed through precautionary approaches that avoid the worst possible outcome of any decision[24]. Indeed, these principles are embodied in the UNFCCC's ultimate objective to avoid 'dangerous' climate change, and the requirement that parties act in a precautionary manner. In this sense, the contemporary 'loss' agenda in climate policy is a powerful reminder that climate impacts are best avoided through mitigation.

The risk of losses arising from climate change is high and cannot be ignored. Priorities for a science of loss outlined here can help better understand and prepare for loss. Understanding loss requires a more situated and socially engaged science that combines theories and methods from the humanities and the social and natural sciences. Researchers need to get into the field and work with affected communities as this is both a *sine qua non* of robust knowledge about loss and an important means by which communities can understand the risk of loss, and begin to respond in ways that lessen future suffering. Such a science must go well beyond the frontiers of contemporary climate change research to include knowledge of values, processes of co-production, and courageous attempts to engage with loss to capture its productive possibilities and minimize its destructive consequences. ❐

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Correction

In the print version of the Commentary 'A science of loss' (*Nature Clim. Change* **6,** 976–978; 2016) the page range of ref. 15 was incorrect in the reference list. This has been corrected in the online versions.