GREENING THE INSURANCE INDUSTRY: NATURE'S ROLE IN MANAGING RISK

Report to the

Water Research Commission

by

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The Institute of Natural Resources NPC
in association with
Econologic
and
Urban Earth

WRC Report No. 2611/1/17

ISBN 978-1-4312-0946-0

January 2018

Obtainable from

Water Research Commission
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Gezina, 0031

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The publication of this report emanates from a project entitled:

The insurance value of ecosystems: streamlining nature-based mitigation solutions to drought/ floods in business (WRC Project No. K5/2611)

Printed in the Republic of South Africa

EXECUTIVE SUMMARY

The insurance sector is facing unprecedented risk. The frequency of extreme events is on the increase and catchment degradation has reduced the buffering capacity of ecosystems – amplifying the impacts of floods, droughts and other disasters.

These events fundamentally impact on human well-being – social and ecological elements do not act in isolation, but rather form a complex and co-evolving social-ecological system that is central to adaptive capacity. Interactions between these elements are, and always have been, dynamic but where human activity unduly perturbs natural systems, this leads to instability that often manifests as risk. Social-ecological systems are also susceptible to systemic risk. A study by RSA and WWF (2014) describes this risk as "environmental systemic risk". Environmental systemic risk is characterised by complexity, uncertainty and potential irreversibility. Often the risk increases in progression over time and generates unexpected secondary events, which might increase impact. The complexity of social-ecological systems is likely to make the occurrence of these effects more fatal and catastrophic. Investing in ecosystems provides an opportunity not only to mitigate the impact of extreme events, but also to manage environmental systemic risk.

This report highlights the role that nature plays in mitigating the impact of extreme events, outlines barriers that limit an industry response and, finally, makes recommendations on possible mechanisms to reduce environmental systemic risk that warrant further investigation.

A naturally functioning ecosystem or ecological infrastructure gives rise to a variety of benefits or ecosystem services including fresh water, clean air, carbon storage, harvestable products and disaster risk reduction benefits. Wetlands, for example, spread the flow of water, which dissipates energy and decreases its velocity thereby contributing to flood risk reduction. United States (US) researchers suggest that a catchment comprising 15% wetlands will reduce flood peaks from 60% to 65% compared with catchments where no wetlands are present (Sather and Smith, 1984). Other ecosystems, including grasslands, forests, soils and riparian vegetation also contribute to either flood attenuation or drought mitigation.

Ecological infrastructure approaches are also proving to be very cost-effective. In the US, ecological infrastructure had lower upfront costs (in some cases by more than 40%) than built infrastructure options in achieving comparable water security goals (Gartner et al., 2013). However, a sustainable and resilient approach to disaster risk reduction will deploy a mix of ecological infrastructure approaches and more traditional built infrastructure solutions.

Despite these benefits and the cost-effectiveness of ecological infrastructure mechanisms, the insurance industry continues to have unpriced risks on its balance sheets and is unable to shift its core money away from risk-generating assets. Interviews with several insurers suggested six key barriers to the implementation of nature-based solutions in South Africa. Firstly, there appears to be a disconnect between scientific knowledge and financial institutions. Environmental systemic risk is not a well-known term in some quarters of the industry; possibly because of limited engagement by scientists with the insurance sector. Also, information does not appear to flow effectively between the sustainability units, analysts, and "on-the-ground" managers, thereby

fuelling the perception by some business units that environmental systemic risk is "not our problem".

Secondly, the translation of scientific information into financial formats is problematic. Scientific information needs to be monetised and link science to social impacts, and demonstrate returns on investment.

Thirdly, natural resources can be classified as complex public goods, meaning that the use or enjoyment of the good by one individual does not reduce its availability to another. The financial community have struggled to adequately address complex public goods largely because of the collective action problem. This raises questions about who is looking at the "big picture" and managing cumulative impacts and use at different scales. This challenge is fundamental to addressing environmental systemic risk.

Fourthly, there are temporal disconnects between industry requirements, and environmental and social impacts that often manifest over relatively long time horizons. Insurers are bound by quarterly reporting requirements, which make adopting a long-term perspective challenging.

Fifthly, innovative product development and appropriate incentives may provide a means to address environmental systemic risk. However, there is often a burden associated with imposing an incentive as someone is required to manage this. Furthermore, some incentives may themselves become a burden, competitively disadvantaging those that have imposed them.

Lastly, regulatory barriers may pose a hurdle to investment in ecological infrastructure by the financial services sector. A clearer understanding of the existing financial policy and legislative framework in relation to investment in ecological infrastructure is needed.

Engagement between insurers, the agricultural sector, and municipalities may leverage the greatest impact in addressing environmental systemic risk. Not only are farmers and municipalities tasked with managing the majority of South Africa's natural assets, but agricultural and municipal debt is also high and on the increase. These stakeholders may therefore be more willing to explore opportunities with insurers that yield both direct financial benefits and indirect ecosystem benefits.

Three mechanisms, which are appropriate for application in the agricultural and municipal sectors, hold potential to reduce environmental systemic risk. The co-designing and piloting of a demonstration project with insurers, research institutions and the agricultural sector may provide an opportunity to update actuarial models with appropriate environmental data. The output could be a product that imposes preconditions in exchange for preferential pricing. Placing selected preconditions would enable insurers to influence management of ecological infrastructure, thereby reducing environmental systemic risk. Co-development of such products would entail an industry-wide approach and should be driven by progressive farmers to ensure that insurance companies are not competitively disadvantaged. The product will also need to be designed in a way that does not impose a significant administrative burden on the insurance industry and does not prejudice farmers who are already implementing sustainable natural resource management.

From a municipal perspective, self-insurance models and green bonds hold potential for investment in ecological infrastructure. A self-insured entity does not pay premiums, thereby freeing up capital to invest in risk-mitigating ecological infrastructure. Self-insurance by municipalities also offers

greater leverage by working with a single entity managing large areas rather than working with individuals. However, risk-generating assets may be located outside the boundary of the municipality thereby limiting its potential to reduce environmental systemic risk. In addition, the Municipal Systems Act requires national government to bail out municipalities in the case of declared natural disasters or if they go bankrupt. In this sense, national government is the lender or underwriter of last resort. The self-insurance model is a very innovative product. However, to prevent risk from shifting to national government, it should only be applied to municipalities with sufficient institutional capacity.

Private and public organisations can raise finance through issuing bonds. In South Africa, municipalities and state-owned entities have entered into the bond market with The City of Johannesburg being the first municipality to list a green bond at the Johannesburg Securities Exchange in 2014. Although green bonds associated with ecological infrastructure have not yet been developed, theoretically it should be possible to do so. Further development and testing of these financial mechanisms to understand their potential and limitations in promoting investment in ecological infrastructure by the private sector is needed.

Addressing environmental systemic risk will ultimately require collaboration and partnerships between insurers, research institutions and government. There is also a need to actively educate insurers and the agriculture sector about activities that are known to reduce environmental risk. Where insurers are aware of activities that contribute to the reduction of the risk, they may be able to take action to incentivise these activities through insurance preconditions and direct investment in risk mitigation. Future research should develop an understanding of the requirements of actuarial models, and translate scientific information into relevant financial formats. This could be achieved, in part, through co-developing and testing a pilot demonstration project with insurers and the agricultural sector. Additional research could further test the development and implementation of existing financial mechanisms (e.g. self-insurance models and green bonds) and also new mechanisms that could be applied by business to prevent environmental degradation.

ACKNOWLEDGEMENTS

The authors would like to extend their sincere thanks and acknowledge the contribution of the following individuals and organisations: Vanessa Otto-Mentz, Portia Bangerezako, Dirk Visser, Jon Lomberg, Jon Duncan, Nico Esterhuizen, Paul du Plessis, Gray Maguire, Duncan Hay, Bonani Madikizela, Inga Jacobs-Mata, Michael Braack and the members of the South African Insurance Association.

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ABBREVIATIONS

DEA	Department of Environmental Affairs
ESG	Environmental, Social and Governance
GDP	Gross Domestic Product
MAR	Mean Annual Run-off
MEA	Millennium Ecosystem Assessment
NFM	Natural Flood Management
RSA	Royal Sun Alliance
UK	United Kingdom
URV	Unit Reference Value
US	United States
USA	United States of America
USACE	US Army Corps of Engineers
WfW	Working for Water Programme
WWF	World Wide Fund for Nature

1 BACKGROUND

Costanza et al. (2014) highlighted the dependence of economic activity on the natural environment when they estimated the value of the world's ecosystem services to be $125 trillion in 2011 – a number greater than global gross domestic product (GDP). Despite this, several studies suggest that this value is not considered in most economic activities and that instead the degradation of the natural environment generates risks to companies and individuals (Trucost, 2013). Addressing this risk is difficult as it emanates in complex socio-ecological systems, but successful investments in the functionality of natural systems can be cost-effective.

This report highlights the role that nature plays in mitigating the impact of extreme events, outlines barriers that limit an industry response, and finally makes recommendations on possible mechanisms to reduce environmental systemic risk that warrant further investigation. While the report is designed to act as a catalyst for discussing and learning about nature-based solutions among insurers and researchers, each aspect of the report has varying degrees of relevance to different readers. For example, the evidence base of the role of nature in mitigating risk may appeal to the insurance sector, while the exploration of further research areas may be of interest to, and require co-operation between, researchers and insurers alike.

This report is based on a series of discussions with insurers combined with desktop research. This is a new area of research and much evidence is anecdotal. Nonetheless, it is an exciting field that presents opportunities for the insurance sector to harness nature's benefits.

2 CHANGING CLIMATE, CHANGING RISK

The insurance sector is facing unprecedented claims due to recent increases in extreme events. In September 2016, City Press reported that South Africa's 2015/2016 drought caused Santam to suffer a loss in the first half of 2016. The company has the highest market share in providing South African farmers with insurance cover against drought. According to the article, Santam received gross crop insurance claims of R469 million during the six months to June of 2016, of which R231 million were drought-related (Brown, 2016). Santam's crop insurance business achieved a nett underwriting profit of R8 million, which is 85% down from the R53 million in the first half of 2015. Two other large companies also provide insurance against drought conditions, namely, Mutual & Federal and AgriSeker, which is the underwriting agent for the Land Bank Insurance Company's crop insurance programme. Mutual & Federal received 1647 drought-related claims in 2016 from the 754 drought-related policies on its books while AgriSeker received 230 claims against its 270 drought policies (Brown, 2016). AgriSeker's claims resulted in a massive loss ratio of 239%, which means that for every R1 paid to the company in premiums, R2.39 had been paid out in claims. The majority of AgriSeker's summer crop claims were maize and sorghum with most coming from the Free State and North West (Brown, 2016).

The adverse effects of extreme events are not limited to farmers and insurance companies offering drought cover. In fact, floods and hailstorms are regarded as the biggest weather-related risks to South Africans. In a single month (November 2013), the insurance industry experienced losses to the value of R400 million due to floods in the Western Cape (Kruger, 2014). Gauteng hailstorms in the same month resulted in losses of more than R2 billion, and floods in Limpopo in January

2013 led to approximately R300 million worth of losses (Watson, 2014). The following year, five of South Africa's nine provinces experienced floods resulting in a spike in storm-related claims. As a result, Standard Insurance reported a 402% increase in storm-related damage claims in March 2014 compared with March the previous year (Watson, 2014).

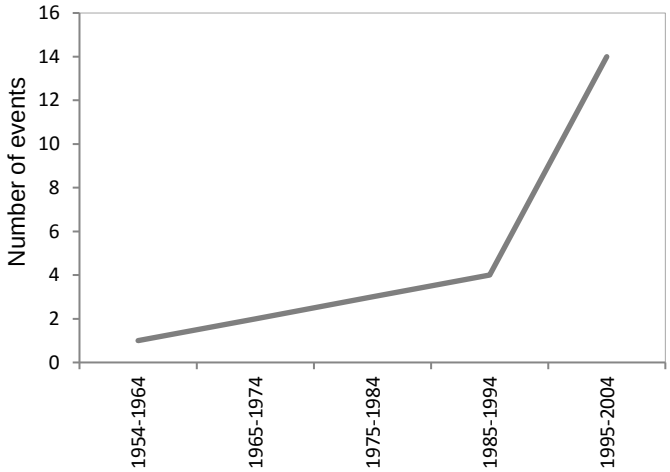

Figure 1: Flood occurrence in South Africa from 1960 to 2004

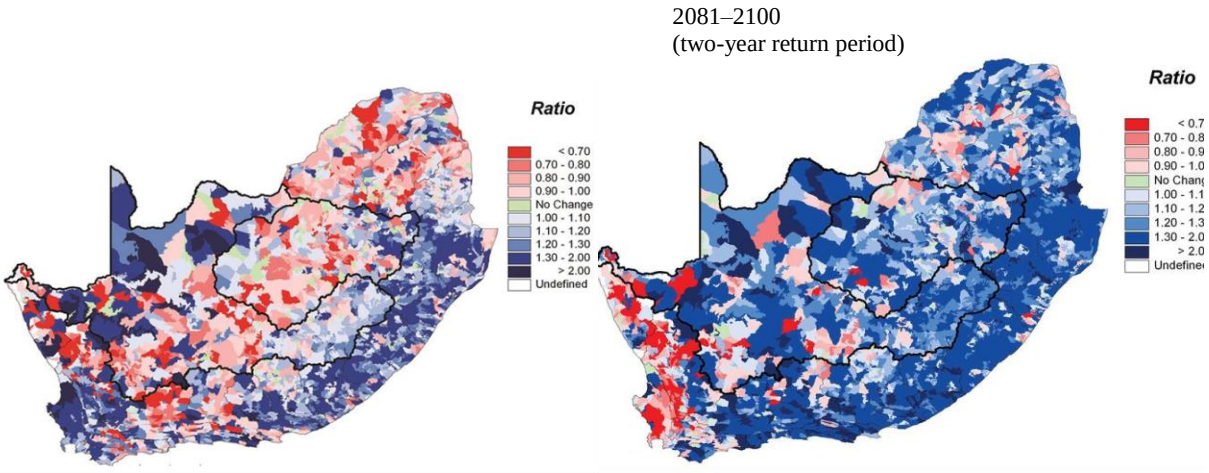

Figure 2. Ratios of intermediate future to present (left) and more distant future to present (right) one-day flood magnitudes for the two-year return modelled using input derived using output from the ECHAM5 climate model (from Knoesen et al., 2009)

Historical data suggests that the frequency of extreme events is on the increase. South Africa has experienced more floods since 2000 than it has in the preceding 40 years. This data is supported by climate simulation models that project that the area subjected to higher flood magnitudes in South Africa could increase into the future (blue areas in Figure 2). The trends are more pronounced in the more distant than intermediate future (Knoesen et al., 2009).

Parts of South Africa are also likely to experience more frequent and severe droughts. Droughts may be classified as meteorological, agricultural and hydrological. Meteorological droughts usually precede other types of drought and are characterised by below normal precipitation for a prolonged period. Agricultural droughts occur when there is insufficient water in the soil to grow a particular crop at a given time. Hydrological droughts occur when water resources, including

aquifers, rivers and dams, are below average or depleted for a prolonged period usually because of below average rainfall (Knoesen et al., 2009).

Climate simulation models suggest that shorter (one- to two-year) meteorological droughts may decrease across most of South Africa while moderate or severe meteorological droughts may not change at all in the future. However, moderately severe hydrological droughts are expected to increase in frequency in certain areas, particularly in the northern parts of the country (pink areas in Figure 3) (Knoesen et al., 2009).

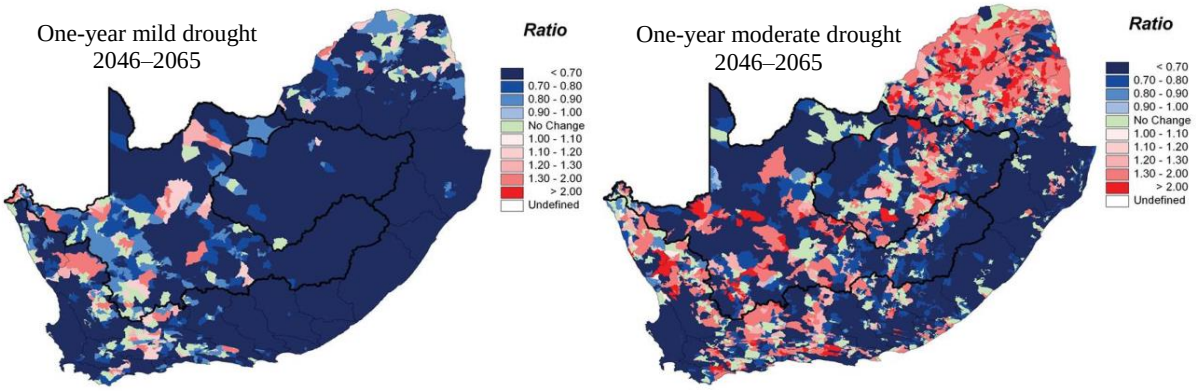

Figure 3. Ratios of intermediate future to present mild meteorological drought of one year's duration (left) and intermediate future to present moderate hydrological drought of one year's duration (right) derived using output from the ECHAM5 climate model (from Knoesen et al., 2009)

3 INSURANCE – SOCIETY'S RISK MANAGER

The insurance sector is widely regarded as society's risk manager (Herbstein, 2016). However, the rise in extreme events is placing increasing pressure on the availability and affordability of insurance. This is evident in rising premiums and previously insurable assets becoming uninsurable. Affordability has a major impact on the demand for insurance, which in turn affects risk pooling. Pooling spreads the cost of losses across many policyholders. For example, when the risk of drought is pooled, the large costs to the few who may suffer losses from a drought are spread between all members of the pool. The premium, or average cost to the members of the pool, is relatively low as only a small number of pool members are likely to suffer a loss (Insurance Europe, n.d.). Rising premiums mean that less people can afford insurance, which in turn would lead to less risk pooling that exposes society and governments to the full cost of uninsured risk. Lower demands for insurance may also affect the viability of the industry and hinder the crucial role that insurers could play in helping society cope with climate change.

These challenges have led insurers to debate whether traditional underwriting approaches are sufficient (Herbstein, 2016). Some industry leaders have suggested that greater levels of co-operation are needed between insurers and insured clients to sustain a healthy insurance industry. Various organisations are exploring ways of reducing risk in the insurance value chain to enhance the resilience of society and the industry. One underutilised option involves harnessing nature's protective services while simultaneously addressing environmental systemic risk. This includes both better alignment between economic activity and the environmental systems that support this activity.

4 A SOCIAL-ECOLOGICAL SYSTEMS PERSPECTIVE

Human well-being and the health of natural systems are inextricably linked. Social and ecological elements do not act in isolation, but rather form a complex and co-evolving social-ecological system that is central to adaptive capacity. Interactions between these elements are, and always have been, dynamic, but where human activity unduly perturbs natural systems this leads to instability that often manifests as risk.

Insurance is a form of risk management used to spread the acute cost of a damaging event across a pool of people over time to avoid a catastrophic impact on the affected people and enable their recovery from the event. For administrative purposes, a division is drawn between short- and long-term insurance. Short-term insurance generally provides protection against theft, loss, damage or destruction of physical objects such as a house or car while long-term insurance covers health or disability events.

Healthy and well-managed ecosystems also help to curb the risk of extreme events. Naturally functioning ecosystems or ecological infrastructure encompasses natural features such as mountain catchments, rivers, wetlands, coastal dunes, and nodes and corridors of natural habitat, which together form a network of interconnected structural elements in the landscape (Cumming et al., 2012). This network gives rise to a variety of benefits or ecosystem services including fresh water, clean air, carbon storage, harvestable products and disaster risk reduction benefits. Moreover, the relative stability and predictability of this network is the foundation on which modern societies and economies have been established. Ecological infrastructure is therefore the asset or stock from which these benefits flow (Cumming et al., 2012). Ecological infrastructure is nature's equivalent of built infrastructure. A sustainable and resilient approach to disaster risk reduction will deploy a mix of ecological infrastructure approaches and more traditional built infrastructure solutions, which are tailored to specific challenges and objectives. For example, effective drought mitigation will require not only the construction and/or maintenance of dams, but also the effective management of upstream catchment ecosystems that play a crucial role in water production and retain sediment, thereby prolonging the lifespan of downstream dams.

5 NATURE'S CONTRIBUTION TO THE INSURANCE SECTOR

5.1 Flood Attenuation

Grasslands assist in flood attenuation by reducing run-off and improving infiltration. A study by the University of Exeter, United Kingdom (UK), demonstrated the role that unimproved or natural grasslands play in flood attenuation in the western UK lowlands. A scenario analysis of the Devon and Cornwall culm grasslands showed that during storm events, 11 times more water rapidly leaves intensively managed grasslands than the natural culm grasslands, thus significantly increasing the risk of flooding downstream (Puttock and Brazier, 2014). Overall results indicate that relative to intensively managed grassland, culm grassland soils also hold more water and store more carbon, which suggests that natural catchments function far better than their intensively managed counterparts.

Riparian vegetation also has attenuation effects during floods. The overall roughness of the vegetation and flow resistance dissipate the kinetic energy of floods. The ability of riparian vegetation to attenuate floods varies according to discharge and the width of the riparian corridor in comparison to the stream channel (Tabacchi et al., 2000). Recent research in South East Queensland, Australia, demonstrated that a healthy riparian zone is extremely valuable for farmers (Ringwood, 2016). In 2013, a major rainfall event dumped 1000 millimetres of rain in 72 hours across the Glengallan and Swan Creek's floodplain in the Condamine catchment. The flood caused extensive erosion along the creeks and the floodplain with many landowners losing up to 500 mm of topsoil.

The event led to the implementation of a flood recovery programme to aid agricultural recovery, which was funded by the Queensland and Australian Governments through the natural disaster relief and recovery arrangements. A component of the programme estimated the value of lost productivity and the cost to restore the damage for each property involved in the programme. The assessment found that several properties on the floodplain had incurred lower damage costs and lost productivity than the rest of the properties. The common factor between these properties was that riparian vegetation was in a reasonable to good condition (Ringwood, 2016). Riparian vegetation in good condition was at least 30 m wide, not grazed or trampled by stock and displayed at least two layers of cover, notably groundcover or grass, and trees (G. Ringwood, personal communication, 26 February 2017).

Table 1. Estimated lost productivity and flood damage (from Ringwood, 2016)

Average approximate cost per:	Whole programme	Three floodplain properties with riparian vegetation
Hectare	= A$700	= A$210
Kilometre of creek bank	= A$50 000+	= A$13 300

Perhaps one of the most studied ecosystems in respect of flood attenuation is wetlands. Wetlands are generally gently sloped and densely vegetated. When water from a stream channel enters a wetland, the flow is spread out across the wetland surface, dissipating the energy and decreasing the velocity of the water. By intercepting storm flows during rainfall events, healthy wetland ecosystems can change sharp run-off peaks to slower discharges over longer periods. Given that it is flood peaks that cause flood damage, wetlands can play an important role in flood risk reduction (Kotze, 2000).

Although limited wetland research has been conducted in South Africa, wetlands function similarly throughout the world (Kotze, 2000). Examples from other countries are therefore useful in understanding the contribution that wetlands make to flood attenuation in a southern African context (Kotze, 2000). As early as 1955, the United States Army Corps of Engineers (USACE) identified the critical role that wetlands played in reducing floodwaters along the Charles River, United States of America (USA), from the devastating hurricane that hit Massachusetts that year. The inflow and outflow hydrographs for the flood event were analysed, which showed that the peak flow was reduced by 65% and delayed three days through the reach (USACE, 1972).

It was estimated that 75% of the natural storage occurred within 17 wetland areas covering approximately 3400 hectares (USACE, 1972). The wetlands were deemed so effective in controlling floods that the USACE purchased them for $7 million rather than building a $30 million flood control structure to protect the City of Boston (USACE, 1972). The study concluded that if these wetlands were drained, the cost of flood damages would increase by $17 million per year (USACE, 1972).

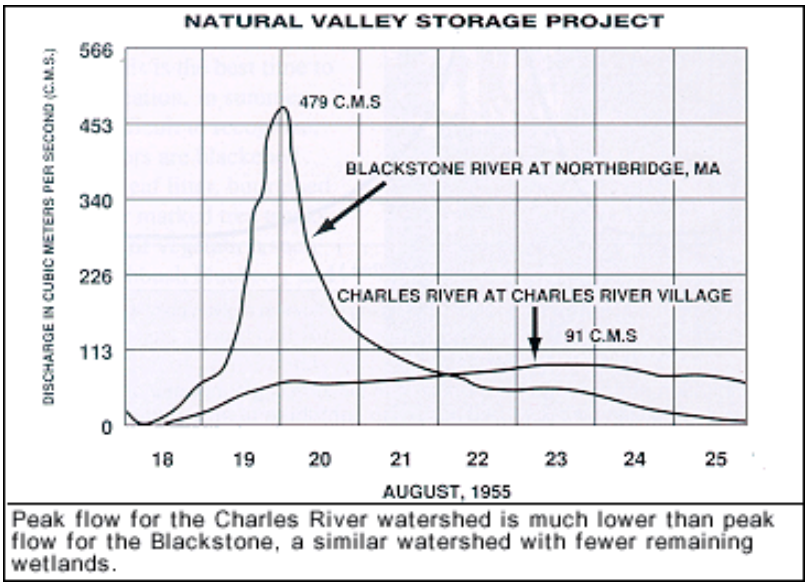

Figure 4. Hydrograph showing reduced flood peak for the Charles River compared to nearby Blackstone watershed with fewer remaining wetlands (from Wright et al., 2006)

The Mississippi Basin has also been the subject of several major floods events. Gosselink and Baumann (1980) estimated that during presettlement times, the forested riparian wetlands alongside the Mississippi had the capacity to store approximately 60 days of river discharge. Many of these wetlands have now been removed through canalisation, leveeing and draining, thereby reducing the storage capacity offered by the remaining wetlands to less than 12 days discharge and resulting in a massive 80% loss of flood storage capacity. Daily et al. (1997) suggest that this extensive loss of wetlands was a major contributor to the severity and damage caused by the 1993 Mississippi Flood. The 1993 event is regarded as the worst flood event in US history, which caused an estimated $16 billion in damages. Researchers propose that these costs could have been substantially reduced if the 5.2 million hectares of wetlands in the upper portion of the Mississippi–Missouri watershed had been restored at a cost of $2 billion to $3 billion (Postel, 2010).

US researchers suggest that a catchment comprising 15% wetlands will reduce flood peaks from 60% to 65% compared to if no wetlands were present (Sather and Smith, 1984). These statistics are corroborated by a recent study undertaken by Saskatchewan Centre for Hydrology, Canada. Wetland storage and run-off were simulated for several scenarios for the Smith Creek watershed, which is located 60 km upstream of the City of Yorkton in south-eastern Saskatchewan. Wetland coverage in the watershed decreased from 24% to 11% between 1958 and 2008 (WEF, 2014). Results of the study showed that for the 2011 flood, complete restoration of wetlands to historical levels reduced the flood peak by almost a third. In contrast, the 2011 flood peak increased by 78% if all wetlands were drained (WEF, 2014).

5.2 Drought Mitigation

Ecosystem functioning affects the availability of water in terms of both quality and quantity. Increased availability of water in a catchment can delay the onset of drought. Effective water management is therefore of direct interest to the insurance industry as it may ultimately reduce their risk.

South Africa's municipal water system depends on water authorities (either water boards, provincial governments or municipalities themselves) securing water at 98% assurance of supply and of nationally stipulated quality. Against this backdrop of rising demand, climate change and ecological degradation that have compromised water flows, caused siltation of dams and impaired the functioning of water treatment plants, the task of securing sufficient water and adequate quality has become expensive. While additional dams, water transfer mechanisms and desalination are possible, the high cost of these options precludes the use of the resultant water by South Africa's poorest municipalities. Comparisons of these augmentation options can be made using unit reference values (URVs), which is a cost benefit metric that essentially represents the cost to produce 1 m^3 over the lifetime of a project. The URV for Spring Grove Dam, the most recent large-scale built infrastructure intervention to augment water supply in the uMngeni catchment, has a URV of R0.71 while URVs for augmentation of supply through waste water treatment and desalination of seawater are substantially higher at between R8 and R12 (Jewitt et al., 2015). By comparison, the weighted average of URVs for ecological infrastructure options in the uMngeni catchment is R2.52, which not only delivers additional water, but also buys a substantial increase in baseflow and a large reduction in sedimentation, both of which Spring Grove will supply in the negative (Jewitt et al., 2015). Ecological infrastructure options may therefore provide a cost-effective answer to generating more water and extending the lifespan of built infrastructure.

Wetlands are regarded as natural sponges. They expand during times of heavy rain and contract to release water slowly throughout the dry season, thereby maintaining streamflow (MEA, 2005). The quantity of water stored globally in wetlands amounts to approximately 11.5 thousand km^3 (Shiklomanov and Rodda, 2003). Although eliminating wetlands is viewed by some as freeing up water for human appropriation, it actually greatly reduces the availability of water. Other ecological infrastructure also plays a critical role in the supply of fresh water. Vegetation, including forests and grasslands, reduces surface water run-off or quick flow and enables rainfall to penetrate the soil. This water, or baseflow, moves along the soil layers of the catchment over a much longer period of time than that of quick flow and results in prolonged flows in rivers for months after the last rain events.

Soil also plays a critical role in storing water. In the uMngeni River Basin, the dam storage capacity is about 800 million m^3, but the soil storage capacity is over double this at about 1640 million m^3 (Hay, 2016). Not surprisingly, the better soil is conserved, the more its water retention potential is increased. Pimentel et al. (1995) note that moderately eroded soils absorb between 10 mm and 300 mm less water per hectare (or 7% to 44% less rainfall) than soils that have not been eroded.

The condition of an ecosystem can greatly determine its ability to function and, therefore, the level of benefit that it is able to provide. Intact systems usually have a greater number of species, which enhances the resilience of the system. Tilman and Downing (1994) found that grasslands that have

more diverse plant communities are more resistant to, and recover more quickly, from drought. This long-term study, which was conducted over 11 years on the native grasslands of Minnesota, included the most severe drought since 1944. The results show that ecosystem resistance to drought is an increasing but non-linear function of species richness. This study implies that the preservation of grassland biodiversity can actively lower the risk of drought.

The condition of grasslands is affected by land management practices. Poor management may lead to overgrazing and the infestation of alien invasive plants with consequent impacts on water supply. A recent study undertaken by Jewitt et al. (2015) determined that the overall volume of dry season baseflow as well as delivery of baseflow per hectare is highest from natural vegetation. In contrast, surface water run-off per hectare was higher from degraded vegetation than from natural vegetation. The study found that the restoration and maintenance of ecological infrastructure in the catchment over a 50-year period would cost an estimated R270 million, but would increase water supply by 3360 million m^3 (7.2 million m^3/year), which translates to an increase in yield of approximately 2% per year for the uMngeni catchment as a whole. This might not seem like much, but would equate to water for 200 000 individuals at 100 litres per person per day. At a retail price of approximately R20/m^3 between a water user association and a user, this would equate to a value of about R144 million per annum. These interventions would also increase baseflow by 23 million m^3 (1.6 million m^3/year).

Results from the study also indicate that baseflows were lower in areas invaded by invasive alien wattles. This finding is supported by a comprehensive body of evidence on the impact of invasive alien plants on water resources. These woody trees and plants, which include species such as black wattle, pines and eucalypts, lower South Africa's water availability by up to 7% (Le Maitre et al., 2000). If unchecked, potential water reductions could be more than eight times greater if invasive alien plants are allowed to invade all suitable habitat (Van Wilgen et al., 2008). A study by Le Maitre et al. (2000) estimates the total incremental water use by invasive alien plants to be 3300 million m^3 per year, which is equivalent to approximately 75% of the mean annual run-off (MAR) of the Vaal River system.

Alien plants also account for about a third of total water use in the Western Cape (31%), followed by KwaZulu-Natal (17%), the Eastern Cape (17%) and Mpumalanga (14%). The greatest reduction (as a percentage of MAR) was found in the arid Northern Cape (17%), followed by the Western Cape (15%) and Gauteng (10%) (Le Maitre et al., 2000). Invasions by alien plants cost the economy an estimated R6.5 billion per annum (approximately 0.3% of South Africa's GDP of about R2000 billion). If these plants are allowed to invade the full extent of their potential range, this value could rise to more than 5% of the country's GDP (De Lange and Van Wilgen, 2010).

The Working for Water Programme (WfW), spearheaded by the Department of Environmental Affairs (DEA), was launched in 1995 to tackle the problem of invasive alien plants. Since its inception, the programme has cleared almost three million hectares of invasive alien plants and simultaneously created about 190 000 jobs for people from the most marginalised sectors of society (DEA, 2016). The involvement of the private sector is seen as fundamental to the continuation of the WfW programme. To date, approximately 80 private companies, including Woolworths, Nedbank, SAB Miller and Sanlam, have invested about R120 million (Isa, 2016). Private sector

investment largely targets specific projects. For example, SABMiller invests in invasive alien clearing in the Outeniqua Mountain catchment in the Western Cape as many of the company's independent hop farmers are located here (Isa, 2016). "Clean water is the single most important aspect of beer brewing," says David Greyling, SABMiller's sustainable development manager in South Africa. "We see great opportunity in creating water stewardship projects that not only ensure sustainable high-quality water, but provide employment" (Isa, 2016).

Although the devastating effects of drought are first realised in the agricultural sector, the ripple effect into other sectors and on individuals is quickly felt. At a local scale, the 2015/2016 drought has had obvious impacts to the 2.9 million households who depend on agricultural production for their finances and food security (Makube, 2016). Crop failure at farm level means that South Africa will need to import an estimated five million tonnes of maize between May 2016 and April 2017, which will drive up food prices. Food inflation will spread outward from South Africa as 40% of all maize consumed in the Southern African Development Community is produced in South Africa (Steyn, 2016). At a food manufacturing level, the shortage of grains and higher prices will result in higher production costs (Makube, 2016).

Of particular concern to the banking and insurance industry is the likelihood of farmers defaulting on loan repayments. At the end of 2015, farmers had their highest ever debt with South African banks: more than R125 billion (Department of Agriculture, Forestry and Fisheries, 2015) (see Figure 9).

Water services in the uMngeni River Basin came close to systemic collapse in 2016. Having been delayed for five years, the Spring Grove transfer scheme was commissioned in April 2016. It, together with the Mearns scheme, pumped 64 million m^3 of water into the uMngeni system in the six months from April to September (Hay, 2016). During the same period, approximately 46–56 million m^3 of water was lost through leaking pipes. Essentially a multi-billion rand dam has been constructed to compensate for leaks (Hay, 2016). However, had this not happened, there would have been insufficient water to sustain supply to Pietermaritzburg and parts of Durban; businesses would have been forced to shut down and insurers would have carried a very high claim burden. This example demonstrates several key points. Firstly, failing municipal infrastructure elevates the importance of ecological infrastructure systems. Under these conditions, an additional 7.2 million cumecs[1] of water in the catchment (the number estimated by Jewitt et al. (2015) that can be generated through restoration and maintenance of ecological infrastructure), is meaningful particularly during a drought event. Secondly, proactive mitigation measures that address both ecological and hard infrastructure are needed to significantly increase water yield and reduce risk.

[1] Cubic metre per second

6 INCORPORATING NATURE INTO RISK

The evidence suggests that ecological infrastructure can and does play an important role in disaster risk reduction, with significant benefits accruing to communities, business, the insurance industry and government. Changes to ecological infrastructure that provides buffering capacity has greatly increased our risk to extreme events. In 2000, the United Nations Secretary General called for the Millennium Ecosystem Assessment (MEA) to examine the consequences of ecosystem change on human well-being. The MEA was a multi-agency initiative that involved over 1360 experts worldwide. The study found that over the past 50 years, humans have altered ecosystems more rapidly and extensively than in any other comparable period in history (MEA, 2005). Although these changes have contributed to substantial advances in human well-being and economic development, the gains have caused substantial and irreversible loss of biodiversity and ecosystem services.

Species extinction rates are almost 1000 times the natural background rate of extinction. Approximately 10–30% of mammal, bird and amphibian species are threatened with extinction (MEA, 2005) and the wild vertebrate population fell by almost a third globally between 1970 and 2006 (Secretariat of the Convention on Biological Diversity, 2010). The Global Analysis of Land Degradation and Improvement estimated that between 1980 and 2003, almost a quarter (24%) of the earth's land area was being degraded (as measured by a decline in primary productivity). This included 10% of grasslands, 20% of cultivated areas and 40% of forests (Secretariat of the Convention on Biological Diversity, 2010). The global extent of wetlands is also estimated to have declined by between 64% and 71% since 1900 (Davidson, 2014).

South Africa shows similar trajectories across all its' ecological infrastructure. Over 50% of the country's wetlands have been destroyed (King et al., 2005), 82% of its rivers are threatened, 44% are critically endangered (King et al., 2005) and more than 60% of the country's grasslands have already been irreversibly transformed (EWT, 2016).

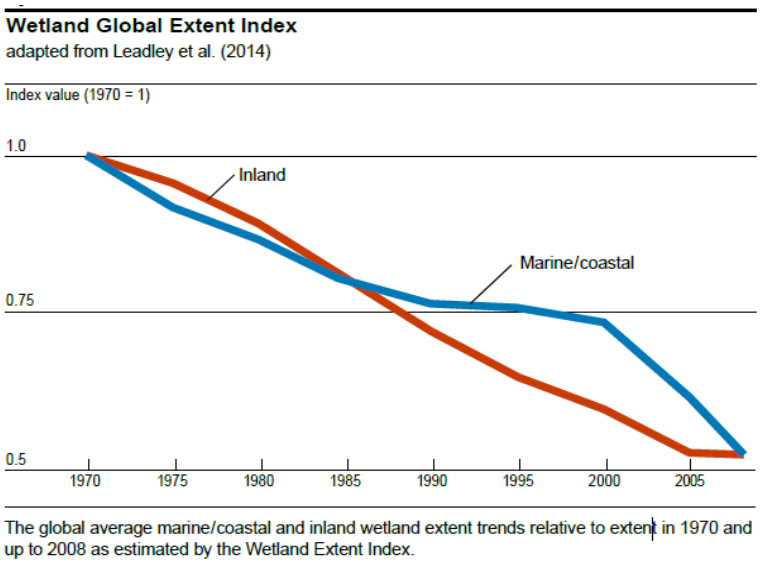

Figure 5. Wetland Extent Index showing an approximate 40% global decline in the extent of both marine/coastal and inland wetlands over 40 years (from RAMSAR, 2015)

The majority of land in South Africa is also at risk of degradation. The country has widespread and severe soil degradation and veld degradation is also problematic. Approximately 70% of land in the country is affected by gully and soil erosion (Gibson et al., 2005). In 1983, it was estimated that almost a third of southern Africa's bush, scrub and savanna vegetation had already been invaded and dominated by woody species (DEAT, 1999).

Unless these problems are addressed, the benefits provided by ecosystems to future generations will continue to decline. While some of these benefits might be provided by engineered solutions, the built environment is not a perfect substitute for the co-evolved natural environment, and some benefits cannot be replicated. Managing floods and droughts will require deployment of mixed methods. Maintaining ecological infrastructure in the first instance and restoring the natural capacity of wetlands, rivers and grasslands to cope with extreme events can significantly lower risk.

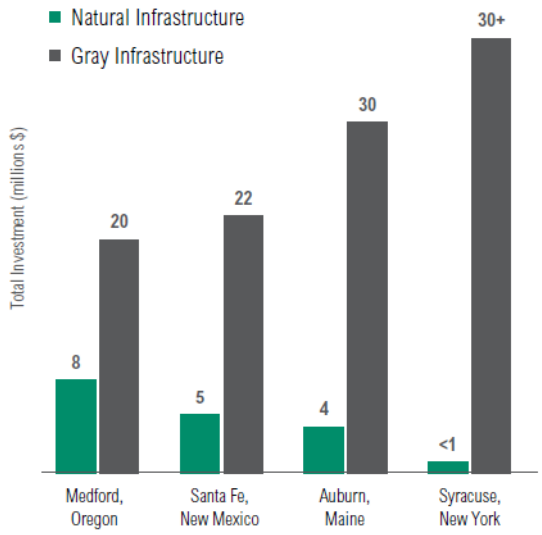

Figure 6. Comparison of green versus grey infrastructure costs for cities to meet water quality requirements in the US (from Gartner et al., 2013)

Ecological infrastructure approaches are proving to be very cost-effective. The World Resources Institute has developed a "green-grey" analysis tool that enables a cost benefit comparison of ecological infrastructure (green) options (such as forest protection or wetland restoration) with built infrastructure (grey) alternatives (such as new water filtration facilities) (Gartner et al., 2013). A comparison of the costs to meet water quality requirements in four US cities illustrates the cost-effectiveness of ecological infrastructure methods. Outputs of the analysis show that in each city, green infrastructure investments had lower upfront costs (in some cases by more than 40%) than grey infrastructure investments in achieving comparable water security goals (Gartner et al., 2013).

Ecological infrastructure approaches are generally most effective when implemented as a diverse portfolio of tools deployed at a river basin scale (Opperman, 2014). These approaches should aim to complement engineered solutions such as dams, reservoirs, canals and irrigation systems, which are crucial for economic activity. Built infrastructure can be enhanced by healthy ecological infrastructure. For example, healthy ecological infrastructure reduces erosion and sedimentation of dams, thereby lowering maintenance costs and prolonging their lifespan. The Welbedacht Dam near Dewetsdorp in the Free State lost almost 80% of its water-holding capacity (from 115 m^3 to 16 m^3 million) within 20 years of completion in 1973 (Le Roux et al., 2015). Improved management of the catchment could directly support the functioning of the dam and increase its lifespan.

Within the catchment, ecological infrastructure interventions should target specific features. For example, the ability of wetlands to deliver flood attenuation and water supply benefits depends on the topography of the wetland site, shape, roughness of wetland surface, location in the catchment,

water regime and permeability of the soil (Kotze, 2000). Interventions should target those wetlands that will provide the "best bang for the buck". This is illustrated in the Greenseams programme, which set out to mitigate future flooding. The program targeted water-absorbing soils in regions experiencing high growth. As of 2013, over 1 million hectares of land capable of storing an estimated 5.2 billion litres of water had been protected (The Conservation Fund, 2016).

The global insurance industry has begun to harness nature's risk reduction benefits and commenced with various projects to restore and protect important ecological infrastructure. The following case studies illustrate different approaches to minimising risk exposure to extreme events.

6.1 Case Study 1. Addressing systemic risk in the Eden District Municipality, South Africa

Communities in the Eden District Municipality are increasingly being affected by extreme events including floods, severe droughts and devastating wildfires. The economic losses of these extreme events amount to millions of rands. Damages from the January 2014 flood event alone were estimated at R790 million while hazard claims that have been incurred by one short-term insurer in Eden since 2014 amounted to R60 million. An increased number of claims from natural hazards prompted Santam to initiate a process to explore what was driving disaster risk and what the insurance sector could do to reduce their risk and increase resilience across landscapes.

A collaborative team of experts from experts from the Council for Scientific and Industrial Research, Santam, WWF South Africa, and the University of Cape Town's Centre of Criminology embarked on a project to understand how changes in Eden's landscape were affecting current and future risk exposure to wildfire, flood and sea storm, and to explore how the insurance industry could respond to ensure its own viability, as well as build the resilience of the socio-ecological system as a whole.

The results indicated that for each of the risks identified (wildfires, floods, and sea storms), drivers of change in the local landscape had the same if not greater effect on risk than climatic drivers. For wildfires, the occurrence of invasive alien trees was a key driver in the local landscape. For flooding, land cover changes recorded over the last 20 years had an equal effect on extreme surface flows as compared to projected future increases in extreme rainfall events. In particular, clear-felling of large tracts of commercial plantations without active rehabilitation coupled with large fires was a key driver of risk.

This proof of concept study provided evidence to mobilise action that led to the launch of several public-private partnerships to clear invasive alien plants and restore catchments. These initiatives demonstrate commitment to address systemic risk and enhance social-ecological resilience.

Information obtained from The Santam Group et al., 2011.

6.2 Case Study 2. Royal Sun Alliance (RSA) and the Mayesbrook Park Restoration, UK

River restoration in Mayesbrook in Barking, East London, was implemented as part of the UK's first Climate Change Park. A significant driver of the project was to update the park's 50-year-old flood management infrastructure using an ecological infrastructure approach (Natural England, 2013). A multi-agency partnership was formed, and RSA insurers donated £300 000 to the project as a research contribution into natural flood management and flood risk reduction through a low carbon approach (European Centre for River Restoration, 2013). This donation helped to leverage further funding.

Restoration included reinstating the 500 m original meandering river channel to help slow flows and create wildlife habitat, rehabilitating 450 m of riverside habitat, and creating a new 1.5 hectare floodplain that provides an additional 15 800 m^3 in flood-storage capacity (equivalent to six Olympic-size swimming pools) (Natural England, 2013).

Improving the 45 hectare Mayesbrook Park has created a multifunctional landscape with a range of benefits. Not only has flood attenuation been enhanced, but air and water quality regulation has improved, recreational facilities are better as many people, who do not have gardens can now access green space, and plants and animals are colonising more areas as the habitat recovers. Other benefits can be seen in social and health aspects, enhancing the quality of life in the area and the well-being of local communities (Kingston University, 2016). The overall benefits relative to investment are substantial. The estimated cost of the restoration scheme is £3.8 million while the calculated benefits over the lifetime of the project are approximately £27 million. This equates to a benefit-to-cost ratio of £7 benefits for every £1 invested (Kingston University, 2016).

The Mayesbrook Park project demonstrates the value of ecological infrastructure and offers learning and participation opportunities for stakeholders including insurance employees. RSA staff were actively involved in tree planting and pond clearing along with other conservation-related activities. The project strongly aligned with RSA's priorities of reducing risks to hazards such as flooding. However, local community members, the local authority and insurers have all benefited from the initiative.

6.3 Case Study 3. Natural flood management in Scotland, UK

Over the last century, human activities and land cover change have altered the behaviour of the River Devon in Scotland, making the area more susceptible to flooding. Risk to business, industry and households was high as flood insurance was no longer guaranteed in high-risk areas in the UK (WWF, 2007). The European Water Framework Directive requires local authorities to achieve 'good ecological status' for rivers. Scotland was the first European country to incorporate the directive into law through the Water Environment Services Act. Under this Act, authorities have a responsibility to promote sustainable flood management, which requires a whole catchment approach. Flood management needs to be economically viable and sustainable, and costly hard infrastructure solutions can be complemented with ecological infrastructure options (WWF, 2007a).

The River Devon project demonstrates sustainable flood management in action. WWF and Clackmannanshire Council worked together with local farmers and landowners to implement natural flood management (NFM) techniques at various sites throughout the catchment (WWF, 2007). At the 0.0175 km^2 Glendey demonstration site in the upper Devon catchment, trees were planted on the hillslopes and down the gully, tree debris were removed from the water course, meanders were created across the wetland, and artificial drains were blocked within the wetland. Several flood events have been recorded since the NFM techniques have been implemented. Data for the largest event (estimated to be a 1:25 year flood event) indicated that after the drains were blocked and the woodland restored, the peak outflow was reduced by over 11%, the volume of water stored over the site increased by over 46%, and the mean velocity in the main channel was reduced by over 70% (WWF, 2007a).

This project not only provides a successful mechanism for securing better insurance conditions, but by restoring the river's natural capacity to attenuate floods, it also reduces the need for costly engineered solutions. Costs of natural flood management of the River Teviot, upstream of Hawick in Scotland, highlight the savings that can be made. The local authority of Hawick considered two hard infrastructure options. The first costs an estimated £28 million and has no upstream attenuation, relying solely on flood walls. The second costs an estimated £95 million and requires the construction of upstream flood attenuation ponds. In contrast, NFM techniques in the appropriate places would cost £2–£5 million and would lower flood risk by the equivalent of 0.5 m to 1 m drop in the flood walls (WWF, 2007a).

7 NATURE AND HUMAN WELL-BEING

Ecological infrastructure is also closely coupled with our physical, psychological and emotional well-being. There is mounting evidence that interacting with nature contributes immeasurably to reducing stress. Ulrich (1984) found that patients in hospital wards with a view of trees recovered more rapidly and required less medication than patients with a view of a brick wall. Several other studies show that nature can be good for health. Exposure to nature has been linked to better health among prisoners, improved attention among children with attention deficit disorder, decreased mortality among senior citizens and lower blood pressure and anxiety among dental patients. Contact with nature has also been shown to reduce stress levels and enhance work performance (Frumkin, 2003).

These studies demonstrate that investing in ecological infrastructure not only reduces the risk of extreme events, but also contributes more broadly to the health and happiness of individuals. Healthy individuals ultimately cost insurers less in claims, which is why insurers incentivise healthy living. For example, Discovery launched the Vitality health promotion programme that aims to reverse negative health trends by motivating and rewarding healthy behaviour (Vitality Group, 2013). In return, Discovery may receive contributions for longer periods due to increased longevity. The benefits of healthy individuals and reduced health care costs not only accrue to insurance industry, but also to government and business in the form of lower spend on state health care and improved performance in the workplace.

8 MANAGING SYSTEMIC RISK AND BUILDING RESILIENCE

Systemic risk refers to the impact of risk on the integrity of an entire system rather than simply the failure of individual parts. Systemic risk exists because of the connections and interdependencies between different assets and activities. Removal or damage to one part of the system may cause catastrophic collapse of the system as a whole.

Social-ecological systems are susceptible to systemic risk. A combined study by RSA and WWF (2014) describes this risk as environmental systemic risk. It is characterised by complexity, uncertainty and potential irreversibility. Often the risk increases in progression over time and generates unexpected secondary events, which may be stronger in impact. The complexity of social-ecological systems is likely to make the occurrence of these effects more fatal and catastrophic. For example, the loss of an oil tanker at sea not only includes the loss of the ship and its cargo, but may also have profound impacts on ecosystems, wildlife, and communities that depend on fishing for their livelihoods.

The RSA and WWF (2016) study cites the Deepwater Horizon oil spill that began on 20 April 2010 in the Gulf of Mexico on the BP-operated Macondo Prospect. The initial accident led to the loss of nine lives, but the well was only declared sealed nine months later. The spill had a consequent effect on the economy and cost BP more than $42 billion (Maritime Executive, 2015). This example highlights another important attribute of social-ecological systems – the presence of feedback loops. Feedbacks are the two-way connectors between system components that can either reinforce (positive feedback) or dampen (negative feedback) change (Simonsen et al., 2014). The insurance challenge is to invest in systems that dampen risk.

While traditional insurance underwriting approaches have focused on direct and immediate results of isolated incidents, social pressures within the social-ecological system make potential risk exposure difficult to contain. Importantly, the environment's buffering capacity has been undermined over time by degradation and is more easily breached by extreme events.

Climate change coupled with degradation of our natural resources not only reduces our defence against extreme events, but also undermines the health and well-being of society. The causal links between environmental degradation and human health are complex; often indirect and dependent on numerous modifying forces (WHO, 2016). Direct impacts on health and well-being occur if ecosystem services are unable to meet social human needs. Loss of ecosystem services may also indirectly affect livelihoods and lead to political conflict. The extent of the impact is influenced by the level of dependence of a community on ecosystem services and other factors such as poverty and education (WHO, 2016).

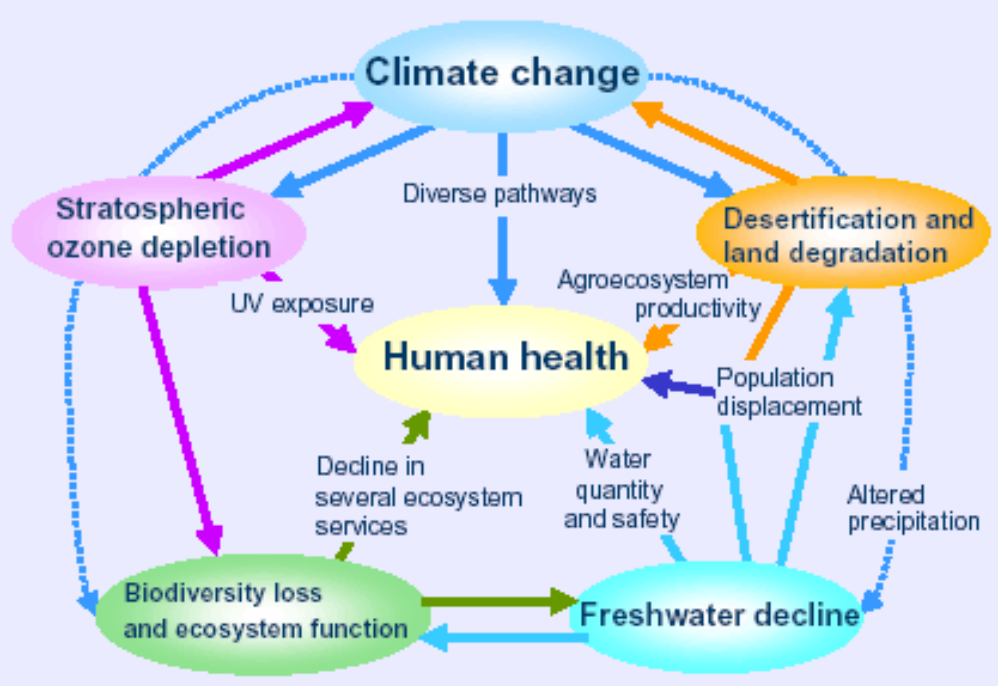

Figure 7. The complex interactions between ecosystems and human health (from WHO, 2016)

Both short- and long-term insurers foot the bill for environmental degradation. While initial effects are felt in the short-term insurance sector, the ripple effects on claims in the health and life insurance sectors are likely to be far greater. In the past 25 years in the US, the insurance industry has paid out more than $50 billion in health, workers compensation, property and casualty claims, as well as litigation resulting from environmental hazards (Jones, 2011). Environmental systemic risk is a ticking timebomb that requires urgent attention (RSA & WWF, 2014). A greater understanding and management of environmental systemic risk provides a major competitive advantage to a company. While restoring and maintaining ecological infrastructure can contribute to addressing environmental systemic risk, other actions can also be taken by the insurance industry.

8.1 Case Study 4. Adopting a social-ecological systems approach – Risk management in the Baviaanskloof, South Africa

In 2014, Santam embarked on a collaborative journey with Four Returns, the Department of Water and Sanitation, and the Deutsche Gesellschaft für Internationale Zusammenarbeit to build a resilient landscape in the Port Elizabeth catchment area (Living Lands, 2014). Port Elizabeth obtains 70% of its water from the Kouga, Baviaans and Kromme catchments. Over the last decade, these catchments have experienced extensive degradation as the result of overgrazing, infestation of alien invasive plants, and poor spatial planning. These changes, coupled with climate change impacts, have led to increased flooding, droughts and fire risks, which decreased the resilience of the area to cope with extreme events (Living Lands, 2014).

The risk to downstream areas, particularly Port Elizabeth, has constrained the potential of the area to grow economically (Living Lands, 2014). Santam's interest is related to risk. Santam have to understand the risk of natural disasters to its client base to ensure accurate underwriting. If the risk becomes too high, premiums increase and there is the potential that the area becomes uninsurable (IWaSP, 2016). A further motivating factor is that water supply issues may increase business downtime in Port Elizabeth. These challenges have incentivised the four partners to promote and implement sustainable land management and water stewardship activities, which increase water supply and reduce the risk of flooding and fire (Living Lands, 2014).

A total of 3.7 million trees have already been planted to restore the degraded catchment area and weirs and gabions have been constructed. Together, the reforestation and weirs help to slow the flow of the water and increase infiltration (Barbee, 2015). All activities are linked to social-ecological restoration. John Lomberg, head of stakeholder relations and corporate social investment at Santam, highlights that the company aims to "keep insurance affordable and reward landowners for the implementation of resilient measures to reduce the impact of climate change and thereby reduce claims to Santam" (Maguire, 2016). By investing part of their CSI budget into improved landscape management, Santam are creating jobs, improving the environment, and reducing their systemic risk.

9 GREENING THE INSURANCE INDUSTRY

A variety of options are available for the insurance sector to reduce their own risks and improve benefits for policyholders, nature, and society at large, in a way that makes business sense.

Degradation of natural resources is caused by human activities that are embedded in unsustainable business practices. Although the insurance industry is aware of and exposed to the financial consequences of these practices, insurers are able to influence individuals and business to be more sustainable through their own underwriting and investment processes. Through its financial services, the insurance industry is a key enabler of the majority of extractive, manufacturing and distribution activities undertaken by its corporate clients. Some of these activities may result in unwanted social and environmental risks. For example, the construction of a large dam may deliver socio-economic transformation but also destroy pristine biodiversity, negatively impact aquatic

resources and require the resettlement of communities. By providing insurance to the construction company, the insurance industry acts an enabler of development activities (CRO Forum, 2010). Where this enabling role makes projects that contribute to continual environmental degradation and destruction of ecological infrastructure viable, insurance companies unwittingly generate a set of long-term liabilities for themselves (CRO Forum, 2010).

Life insurance companies receive money in the form of insurance premiums, which are invested in the global economy in line with regulations and mandates to be able to meet future claims. Invested assets and associated returns are significant. In 2015, invested assets for long-term insurers in South Africa, which comprise the group financial assets as well as the cash and cash equivalents of the insurers, totalled more than R2 trillion. This included Sanlam's invested assets of R593 billion, Liberty's invested assets of R407 billion, MMI's invested assets of R407 billion and Old Mutual Emerging Markets' invested assets of R652 billion (PWC, 2016). The average return on these invested assets for long-term insurers was 7.5%. The allocation of these investments has a significant influence on the nature of economic activity.

These portfolios of investments and policies allow for diversification and stabilisation of losses. However, insurers can use returns to manage environmental systemic risk by investing in companies that minimise environmental costs in their production or actively investing in rehabilitation of the natural environment. Based on a data set of over 800 companies for the period 2002 to 2010, Figure 8 shows the value at stake if companies had to pay the environmental costs of their production (KPMG, 2012).

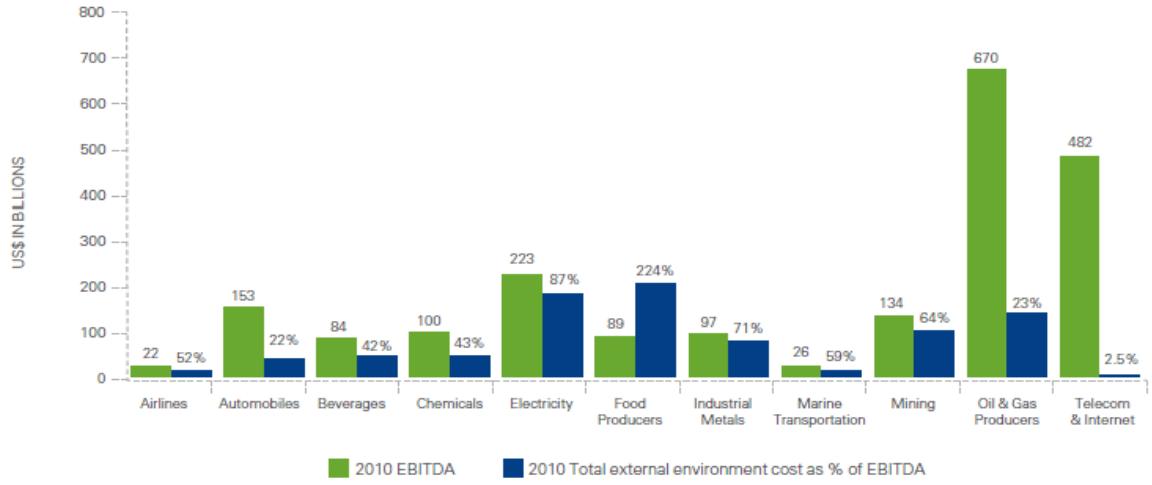

Figure 8. Average environmental costs per sector (from KPMG, 2012)

The CRO Forum (2010) suggests that the insurance industry should consider the potential sustainability impacts of business transactions and incorporate these considerations into holistic risk management processes. Ideally, the insurance industry should make conscious decisions in managing and accounting for sustainability impacts in their business transactions.

Financial institutions seeking to raise new capital, and indeed those managing large funds, are required to report against environmental, social and governance (ESG) criteria. This reasonably novel requirement on South African companies has up to now been seen as a matter of compliance. Adopting a more proactive stance to ESG reporting, and the relationships between these three

parameters, can lead to more profitable allocations of capital by reducing the raft of risks that emanate from ecological degradation. For private companies, investing in natural systems is tricky as these assets tend to be public goods that do not generate financial returns. At the same time, however, private companies ignore these assets at their own peril, as they are essential to the ability to generate financial returns and can be used to reduce risks of flooding, fire, drought and social inequality. This requires greater alignment of investment and risk management strategies and should ideally be done in partnership with public sector agencies responsible for public goods.

There are also opportunities for innovative product development. Many international insurance companies have introduced "green" products aimed at shifting consumer preferences to more sustainable behaviour. While many of these products promote the transition to a low-carbon and resource-efficient economy including clean energy projects, green buildings and energy efficiency other innovative products address coverage gaps such as micro-insurance for weather-related hazards (Mills, 2012). For example, in 2005 the Opportunity International Bank of Malawi and the Malawi Rural Finance Corporation offered a packaged loan and index-based micro-insurance product to groups of groundnut farmers organised by the National Smallholder Farmers Association of Malawi. The farmer pays a higher interest rate, which includes a weather-related premium, which the bank pays on to the insurer, the Insurance Association of Malawi. During a severe drought, the farmer would pay a fraction of the loan while the remainder would be paid by the insurer directly to the bank. The bank benefits in that the farmer is less likely to default creating a stabilising effect on the bank's portfolio and risk profile (Mechler et al., 2006). Participation in such a mechanism could include a condition for sustainable land management practices, thereby conserving ecological infrastructure and addressing systemic risk.

Insurers also have the opportunity to incentivise investment in natural assets and associated risk reduction behaviour through the price they set on their premiums. For example, risk-based pricing in the National Flood Insurance Program in the United States imposes higher premiums on those that live in flood prone areas. Although there are affordability debates, risk-based pricing indirectly affords some level of protection to flood-reducing ecological infrastructure. A prerequisite for implementing risk-based pricing is an understanding of the potential risk. This in turn will require closer collaboration with information providers including researchers, non-governmental organisations and risk modellers.

Investment in ecological assets can represent cost-effective risk mitigation measures. The implication is that insurers have unpriced risks on their balance sheets and are not investing optimally to manage risks. For poor people, however, who do not have access to insurance products but whose poverty and livelihood quest does impact upon systemic risk and insurance companies, investments in ecological infrastructure can build resilience that reduces risks.

10 BARRIERS TO IMPLEMENTATION OF NATURE-BASED SOLUTIONS

A combination of face-to-face and telephonic interviews were conducted with several key insurers including Santam, Sanlam, Old Mutual and Nedbank to obtain their views on how nature has been used locally to mitigate risk, what the potential data and information needs of the insurance industry are, and what challenges they may have encountered or foresee in investing in nature to minimise risk. In addition, similar discussions were held with the South African Insurance Association, and

questionnaires were circulated to its members. The resulting information was collated to identify barriers to the implementation of nature-based solutions in South Africa. These have been categorised into six broad themes.

10.1 Disconnect Between Scientific Knowledge and Financial Institutions

The concept of environmental systemic risk is poorly understood in some quarters of the insurance sector. Although environmental systemic risk seems to be high on the agenda of the sustainability units of various insurers, the concept did not have much traction with some other business units. Part of the problem is awareness. There has been limited engagement by scientists with insurers, possibly because such engagement processes are daunting. People are reluctant to engage because both scientific and financial information can be difficult to understand, and they feel uncomfortable. In addition, there appears to be a disconnect within the institutions themselves. Information does not seem to flow effectively between the sustainability units, analysts, and on-the-ground managers. This contributes to a lack of understanding and fuels the perception that measures to address environmental systemic risk are "not our problem". The disconnect between scientific knowledge and insurers could potentially be addressed through the co-production of knowledge.

10.2 Quantification of Interventions and Outputs

Those consulted for this study highlighted difficulties with factoring non-financial information into the decision-making process. Scientific information needs to be converted into rands and cents or productivity metrics that can be incorporated into standard models. Importantly, this information needs to demonstrate returns on investment and link science to social impacts. For example, the decline of wild bees in south-west China due to excessive pesticide use and destruction of habitat has forced farmers to hand-pollinate their apple and pear orchards (Goulson, 2012).

Although monetising scientific information would help to address this challenge in part, far more work is needed with actuarial scientists in the sector to understand which aspects of their models consider natural resources and what type and format of data is required to assess the potential for nature-based solutions. And then there is the challenge of getting the actuarial scientists to incorporate the information. One suggestion offered by an insurer was to identify a well-respected actuarial scientist and use him as a model for how things could be done.

10.3 Complex Public Goods

Natural resources can be viewed as non-excludable and non-rivalrous public goods. In other words, people are not restricted in their use of the good, and simultaneous use does not reduce the availability or utility of the good. However, their supply is not infinite, which makes them susceptible to the "tragedy of the commons" (Penn State University, 2016). Although the financial community has been good at articulating private goods, they have struggled to address complex public goods adequately. This is largely because of a collective action problem with difficulties arising in the provision or maintenance of public goods. This raises questions about who is looking at the big picture, accounting for cumulative impacts, and managing use at different scales. Addressing these challenges are critical for managing environmental systemic risk. However, some

insurers highlighted that interventions that address environmental systemic risk are often viewed as social projects, and as such are perceived to fall outside the core business of insurance. Addressing the challenge of complex public goods will require involving all role-players (including the Reserve Bank, Department of Rural Development, Department of Trade and Industry, financial institutions, insurers and landowners across a catchment), a shared recognition of the collective action problem, and building of social compacts.

10.4 Temporal Disconnect

Addressing environmental systemic risk is largely associated with temporal problems. Three key temporal issues surfaced during the consultations. Firstly, historical data is often used to inform decision-making even though the past is generally a poor proxy for the future. Secondly, social impacts are often measured qualitatively and have long time horizons that do not align well with industry targets. Thirdly, the need for quarterly reporting can make adopting a long-term perspective challenging. As a result, insurers are not incentivised to address environmental systemic risk, the consequences of which will only manifest over much longer time horizons rather than the quarterly review period. Various organisations (including Focusing Capital on the Long Term, Harvard Business School, and McKinsey & Company) have focused their attention on developing practical tools and approaches to encourage long-term behaviours in business and investment decision-making. Uptake of their research, educational resources and actionable recommendations will contribute to addressing environmental systemic risk.

10.5 Challenges with Product Development and Incentives

Although insurers acknowledged the potential use of incentives to encourage clients to reduce their risk using nature, they were unable to cite any examples of these in practice. Several insurers did express an interest in co-developing products that impose conditionality's in exchange for reduced premiums or preferential pricing thereby encouraging risk-mitigating behaviour. However, the design and application of incentives needs to be considered carefully. Often there is a burden associated with imposing an incentive as someone is required to manage this. In addition, some incentives may themselves become a burden, competitively disadvantaging those that have imposed them. An industry-wide approach is therefore needed that also considers commercial imperatives and social responsibilities.

10.6 Regulatory Barriers

The RSA & WWF report (2014) identified regulatory barriers as a key hurdle to adoption of an industry-wide approach to manage environmental systemic risk in the UK. In South Africa, however, it is not yet clear what regulations help or hinder the financial services sector to invest in ecological infrastructure. Future research should explore the existing policy and legislative framework to identify barriers and investigate how this framework could be altered to promote investment in ecological infrastructure.

11 OPPORTUNITIES FOR ACTION

Access to capital and debt has substantially increased, but has been blind to ecological degradation. Agricultural debt in South Africa is high and is on the increase. The total farming debt in December 2015 was estimated at R133,089 billion, as against R116,576 billion in 2014, which is an increase of 14.2% (Figure 9) (Department of Agriculture, Forestry and Fisheries, 2015).

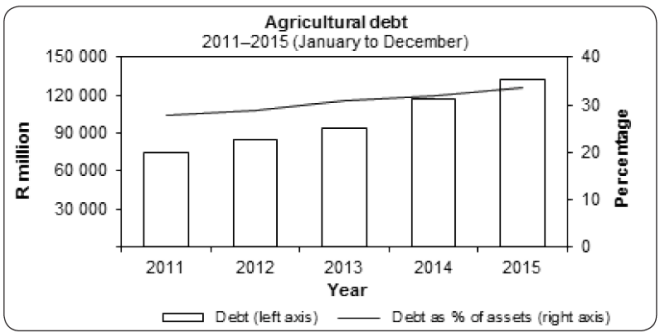

Figure 9. Agricultural debt in South Africa between 2011 and 2015 (from Department of Agriculture, Forestry and Fisheries, 2015)

Similarly, the World Bank reported that South African municipalities require more than R500 billion to upgrade and build new infrastructure (Department of National Treasury, 2011). It is estimated that metropolitan and secondary municipalities alone require approximately R271 billion (between 2009 and 2019) of which R26 billion is to eradicate backlogs and R245 billion is to rehabilitate aging infrastructure and build new infrastructure to support growth (Figure 10) (Department of National Treasury, 2011).

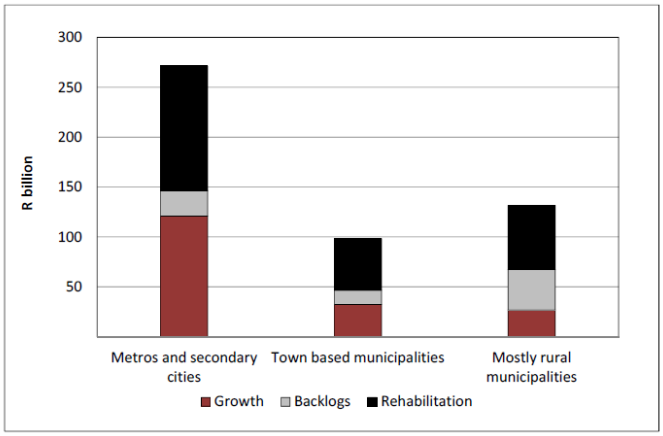

Figure 10. Municipal infrastructure investment requirement, 2009 (from Department of National Treasury, 2011)

The primary sources of finances available to municipalities are internally generated funds and transfers from national government. However, these are usually insufficient, and municipalities are forced to leverage private finance through borrowing, development charges, land leases and private public partnerships. Figure 11 shows the trend in private and public sector lending to municipalities between 2005 and 2010. Outstanding municipal borrowings as at the end of 2010 were estimated at R38.1 billion, as against R18.7 billion in 2005, which is an annual average growth of 15% (Department of National Treasury, 2011).

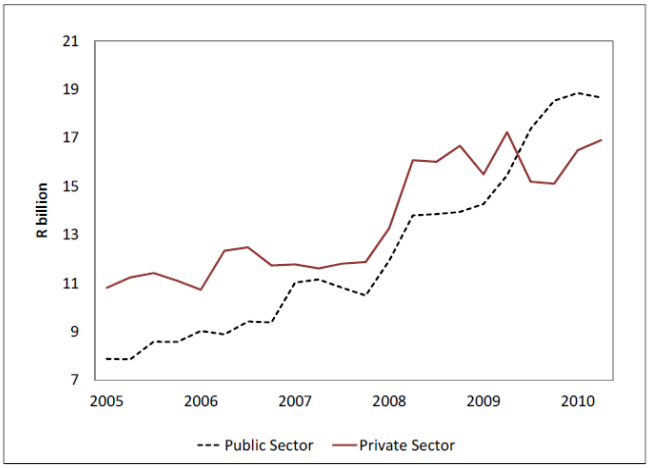

Figure 11. Trends in municipal borrowing market (from Department of National Treasury, 2011)

This increase in debt demonstrates that banks and insurers are important players in contributing to sustainability. However, simultaneous to rising debt has been an increase in ecological degradation. An analysis of land cover changes between 1994 and 2011 in KwaZulu-Natal revealed a massive loss of 7.6% of natural habitat in only 6 years (Figure 12) (Jewitt et al., 2015a). At a national scale, the extent of land transformation in 2005 was 15.7% (Jewitt et al., 2015a). The sustainability agenda has struggled to keep up with these changes. Degradation has now reached a critical point and we are faced with multiple crises and the potential collapse of the social-ecological system.

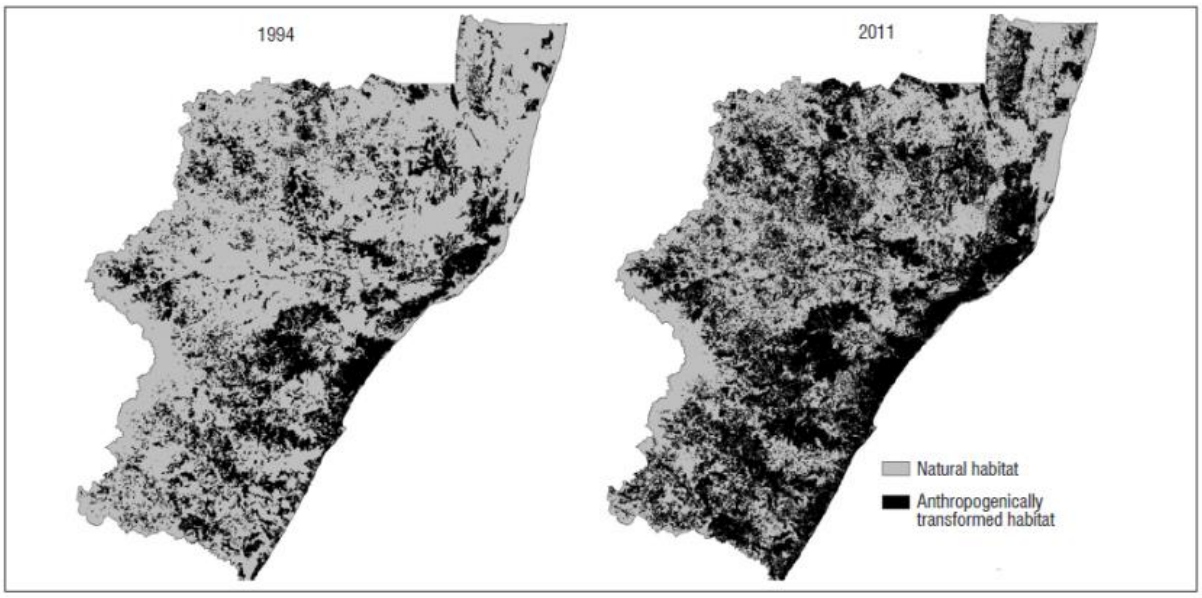

Figure 12. Accumulated transformation in KwaZulu-Natal from 1994 to 2011 (from Jewitt et al., 2015a)

While most players have started to talk about systemic risk, this research revealed that none of them are able to shift their core money away from risk-generating assets. Banks and insurers acknowledge that they are not experts in managing natural resources, while farmers and municipalities are tasked with this responsibility on a daily basis. Given rising agricultural and municipal debt, these stakeholders may also be more willing to explore opportunities that have both direct financial benefits and indirect ecosystem benefits. The agricultural and municipal sectors therefore present an opportunity for action. Through this research we identified three mechanisms which warrant further investigation, hold potential to overcome some of the barriers to implementation of nature-based solutions, and which could be used to address environmental systemic risk.

11.1 Co-development of Products with the Agricultural Sector

Those consulted for this study expressed an interest in the co-development of products. The KPMG survey of the insurance industry in 2012 also suggests that partnerships between companies and research institutions that update actuarial models may reduce the burden on individual companies (KPMG, 2012). The co-designing and piloting of a demonstration project with the agricultural sector, in which actuaries are engaged from the outset, is recommended as a key area for future research. This approach would facilitate the development and tailoring of products that contribute to the objectives of landowners and insurers while simultaneously addressing environmental systemic risk.

Through these products, insurers could impose preconditions in exchange for preferential pricing. Placing preconditions would enable insurers to influence behaviour, particularly in respect of better management of ecological infrastructure, thereby reducing environmental systemic risk. Some banks already use preconditions on the provision of finance to influence behaviour. For example, banks will not fund new agricultural buildings unless there is proof that the farm has complied with Environmental Impact Assessment regulation requirements and have the necessary water use licence to support the level of farming as detailed in the application for finance (McKenzie & Cartwright, 2015). Another example of using preconditions in the insurance sector is the management of fire risk. In the uMngeni Catchment, insurers were found to offer lower premiums and excesses in exchange for their client putting specific fire risk management measures in place (McKenzie & Cartwright, 2015). One insurer was even investing directly in promoting the safe harvesting of honey in the catchment since poor harvesting activities were known to increase fire risk (McKenzie & Cartwright, 2015).

Insurers stressed that the co-development of products would entail an industry-wide approach and should be driven by progressive farmers. In this way, insurers would not be competitively disadvantaged. In addition, a range of government entities would need to be involved such as the Reserve Bank, Department of Rural Development, Department of Trade and Industry, as the risk shifts to government if all parties pull out.

Although the preconditions could be developed with progressive farmers, the process would also require broad buy-in from all farmers if the collective action problem is to be addressed adequately. The extent to which this mechanism can address the collective action problem would depend on how many farmers in a particular area are insured. McKenzie and Cartwright (2015) note that that most farmers do not insure against the full suite of risks that they face because of the high cost of insurance. The preconditions should also not prejudice farmers who are already implementing suitable natural resource management. Instead, the idea would be to encourage most farmers who do not implement appropriate natural resource management interventions to do so, with benefits accruing to a range of stakeholders including farmers, insurers and government. Developing such products would require an intermediary to work between the insurers (or banks) and the farmers with the success of the products dependent on early adopters.

Interviews with Sanlam revealed that outputs of their climate models have rendered some areas of the country uninsurable. However, the implementation of improved natural resource management may provide sufficient risk mitigation that insurers are prepared to revisit the potential to insure farmers in these regions. These areas may therefore offer useful case studies for the co-development of products.

McKenzie and Cartwright (2015) highlight that banks have an incentive to minimise the number of issues that need to be investigated by their agricultural division when responding to a loan application so as not to lose clients to competing banks. Similarly, the level of burden of precondition products on insurers will need to be considered. Conditionality does, however, respond well to the scientific-financial disconnect and facilitates an increased understanding of environmental systemic risk.

11.2 Self-insurance by Municipalities

Self-insurance is a mechanism whereby by a pool of money is set aside to be used in the event of unexpected losses. Self-insurance may often be more economically viable than buying insurance from a third party as insurers charge a premium to make a profit. Instead of paying these premiums, the self-insured entity should be able to save money by setting this money aside or investing it themselves. However, sufficient funds must be on hand should they be needed. The City of Johannesburg has recently become self-insured and is underwritten by a local insurance company. This affords the City the ability and capital to invest in risk-mitigating ecological infrastructure. Self-insurance by municipalities also offers greater leverage by working with a single entity managing large areas rather than working with individuals. This is a very innovative product that requires cities to think differently and could be explored for use by other municipalities.

This model does exhibit several limitations. Firstly, it requires institutional capacity and may therefore not be appropriate for some municipalities. Secondly, important risk-mitigating ecological infrastructure may be located outside the boundary of a municipality, thus limiting the potential to address environmental systemic risk. Thirdly, some municipalities in South Africa may simply not be purchasing insurance. Lastly, the Municipal Systems Act requires national government to bail out municipalities in the case of declared natural disasters or if they go bankrupt. In this sense, national government is the lender or underwriter of last resort. In order to prevent risk simply shifting to national government, it is critical that this mechanism is only applied in municipalities with sufficient institutional capacity to effectively manage the model. Nonetheless, this product does require further investigation particularly given that it addresses the issue of complex public goods and bypasses the challenge of temporal disconnects within the insurance sector.

11.3 Green Bonds

Green bonds were suggested in one of the interviews as a potentially useful vehicle for raising capital to invest in ecological infrastructure. Private and public organisations can raise finance through issuing bonds – where the issuer is the borrower and the bond holder is the lender. The interest is paid at fixed intervals to the bond holder and/or the principle amount is repaid at a predetermined later date (Audouin et al., 2016). Audouin et al. (2016) note that the insurance sector is required to manage the risk appetite of their investments and maintain liquidity and solvency of such investments in line with their commitments to policyholders; green bonds may provide an investment vehicle to do this.

In South Africa, municipalities and state-owned entities have entered into the bond market (Cartwright et al., 2015). The City of Johannesburg became the first municipality to list a green bond at the Johannesburg Securities Exchange in 2014. The money raised from the R1.46 billion bond is being used to finance green initiatives such as the Bio Gas to Energy Project and the Solar Geyser Initiative (NBI, 2015).

Green bonds are attractive as the “green” nature of the asset is often used to secure the bond with better terms than would otherwise have been in the case (Mander et al., 2015). Municipalities are also able to ring-fence the money and only use it for investment in the green economy. Those

consulted during this research noted that the private sector is looking for big deals and that municipalities would need to build large investment portfolios.

In reference to bonds issued by eThekwini Municipality and Umgeni water, Cartwright et al. (2015) note that it should be possible to raise finance for a further bond that could be spent on reducing water risks through ecological infrastructure. However, Mander et al. (2015) state that "… currently the market is considered to be too tenuous for the development of green bonds associated with natural capital". This is largely because the banking sector shows significant aversion to unknown and untested business models (Mander et al., 2015). It would appear that far more work is needed around green bonds, particularly those associated with ecosystem services as opposed to renewable energy projects (Audouin et al. 2016). Nonetheless, investment in these vehicles by the insurance sector may provide one avenue for managing environmental systemic risk.

12 CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

The insurance sector can and should play an important role in mitigating the impacts of extreme events and managing environmental systemic risk. As key contributors to the economy, which have reach into people's lives, businesses and communities, they are well-placed to do so. The South African Insurance Association highlights that while insurers are not environmental experts, they clearly are risk experts. They also have a vested interest in reducing risk and promoting sustainability. While a more detailed assessment of the potential use of nature-based solutions to manage risk in South Africa is needed, some clear areas of focus have emerged:

- ***Foster partnerships with insurers, research institutions and government***. Reducing environmental systemic risk requires collaboration. It is vital that insurers, research institutions and government talk to one another and work together – each as experts in their fields, to better understand and manage risk.
- ***Understand the requirements of actuarial models, and support research that translates scientific information into relevant financial formats***. Insurers rely on information and knowledge to effectively manage risk. There is a clear need to better understand the type and format of information required by actuaries to quantify, predict and underwrite risk, and to promote and fund research that enables the inclusion of environmental information in risk assessment models.
- ***Explore potential regulatory barriers and investigate how the policy and legislative framework could be altered to promote investment in ecological infrastructure***. Investment in ecological infrastructure may require legislative, policy or operational changes, or a combination of these, within the financial sector. A clearer understanding of the existing financial policy and legislative framework in relation to investment in ecological infrastructure is needed.

- ***Support and fund the co-development and testing of a pilot demonstration project with insurers and the agricultural sector.*** The insurance sector has expressed an interest in co-producing products that reduce environmental systemic risk through better management of ecological infrastructure. This presents an exciting opportunity to move science into practice while simultaneously providing a space for collaboration and learning among researchers, actuarial scientists, landowners and government.
- ***Actively educate insurers and the agriculture sector about activities that are known to reduce environmental risk.*** Where insurers are aware of activities that contribute to the reduction of the risk, they have taken action to incentivise these activities through insurance preconditions and direct investment in risk mitigation. This is illustrated by the experiences of fire risk management in the insurance sector. In addition, many participants in the agricultural sector undertake a range of risk reduction activities that they know to be effective. If both sectors were better educated on activities that reduce environmental risk, it will promote up take of these activities.
- ***Further develop and test the implementation of existing financial mechanisms*** (e.g. self-insurance mechanisms and green bonds) to enable investment by private sector in ecological infrastructure. A number of mechanisms already exist, which could facilitate private sector investment in ecological infrastructure. More work is needed to fully understand their potential and limitations in addressing environmental systemic risk.
- ***Explore other mechanisms that business can apply to prevent environmental degradation.*** Financial institutions and insurers potentially act as enablers of development, which in turn may affect the environment negatively. The inclusion of environmental requirements as a prerequisite to finance or insurance should be revisited.

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