EMBEDDING ECOSYSTEM SERVICES INTO POLICY (EESP)
LEARNING SERIES

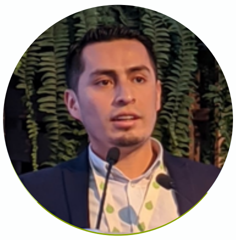
Session 1: Malawi 2063 - Ecosystem Services and National Planning in Malawi

Day 2

about this session

This session will be a deep dive into the Country Climate and Development Report (CCDR) for Malawi, published by the World Bank in September 2022. The report will be used to discuss the status of natural capital in Malawi, and present estimated changes in Malawi's natural capital in the future under 4 scenarios. It will then elucidate the effects of these changes on 4 sectors - labor productivity, land management, agriculture, and infrastructure. Finally, the discussion will move towards the need of strategic investment in sustainable land management to achieve resilient growth.

Keywords: Country Climate and Development Report, land degradation, land management, natural capital, climate change



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learning objectives

- Develop a comprehensive understanding of the impact of changes in Malawi's natural capital on labor productivity, agriculture, infrastructure and climate financing.
- Develop a comprehensive understanding of estimated changes in natural capital under four scenarios of the future.
- Analyze data from published reports, and draw trends to apply to policymaking.
- Brainstorm natural capital areas for investment, to improve ecosystem services and promote sustainable development.

BELA Biodiversity, Ecosystems, & Landscape Assessment

Embedding Ecosystem Services into Policy (EESP) Learning Series

The Benefits of Natural Capital Assessment in Malawi

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GPS Global Program on Sustainability

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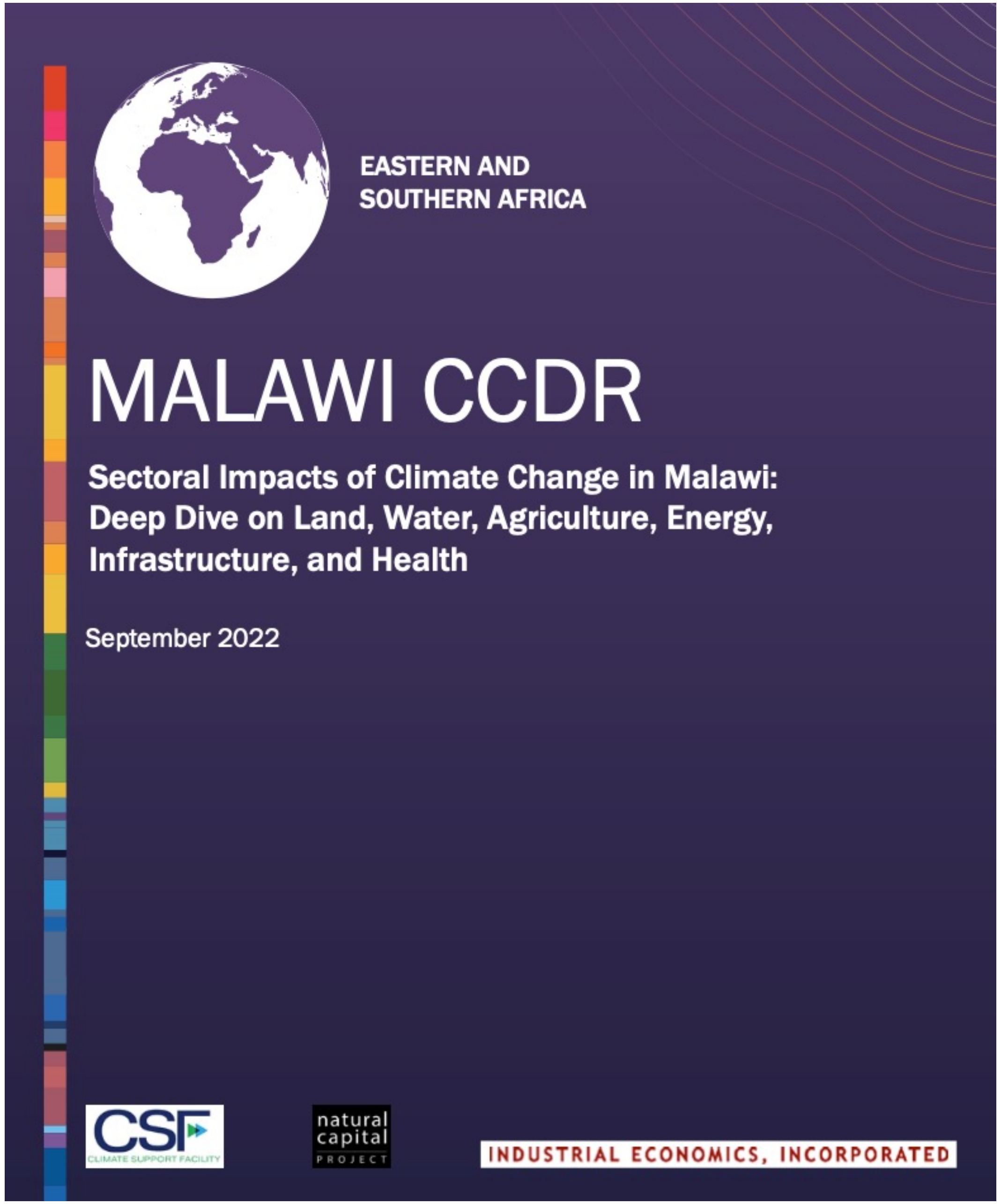


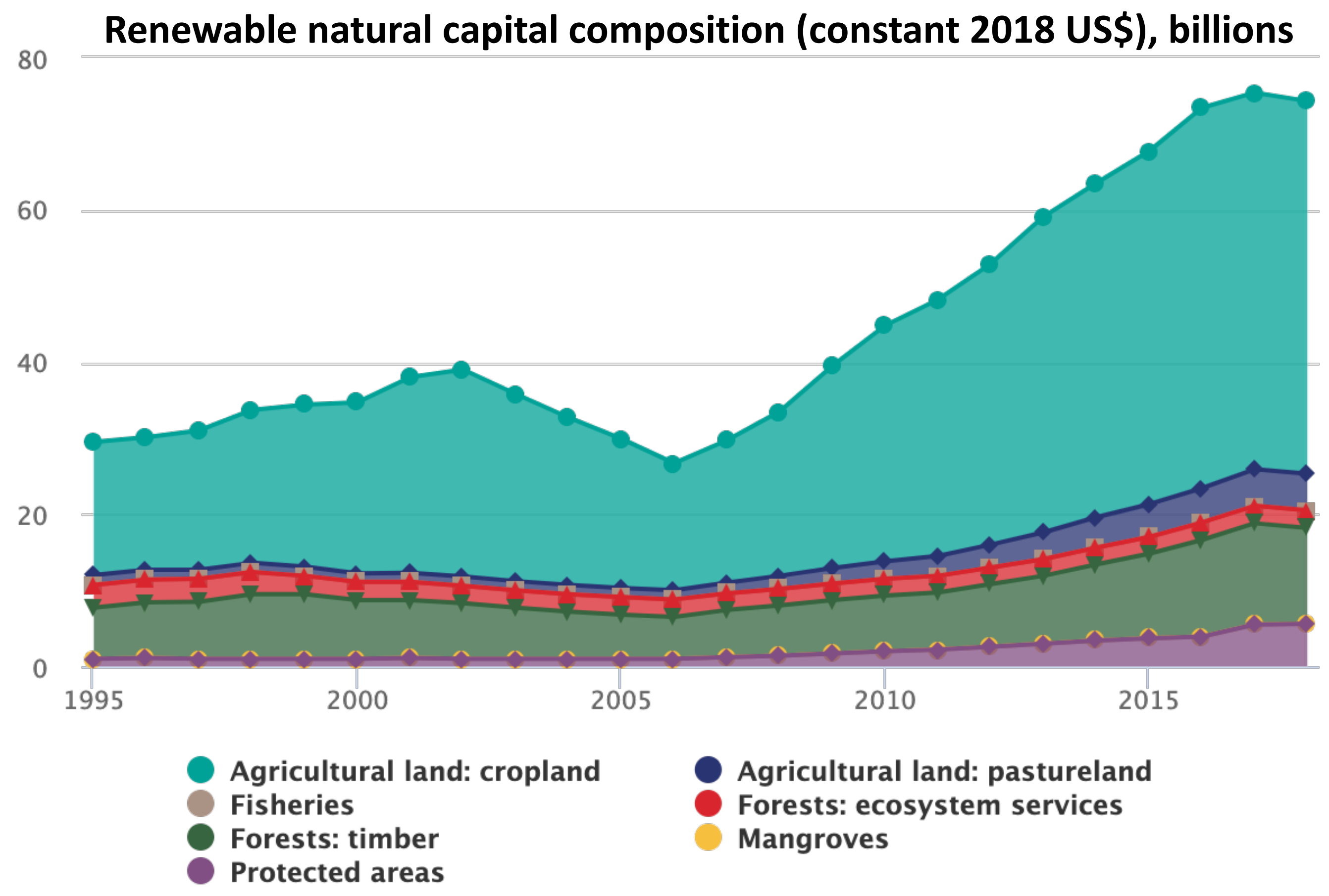
Guiding questions

- What is the status of Malawi's natural capital?
- What do changes in extent and condition of natural capital mean for agriculture, infrastructure, and climate financing?
- Where does investing in Malawi's natural capital provide the best improvement in ecosystem services?

Status of Malawi's natural capital

Natural capital is becoming increasingly valuable for Malawi

- Agriculture and pastureland value increased almost 2x
- Timber value increased 88%
- Value of natural assets in protected areas increased almost 5x



Source: Changing Wealth of Nations 2021: Managing Assets for the Future report (CWON 2021). www.worldbank.org/cwon

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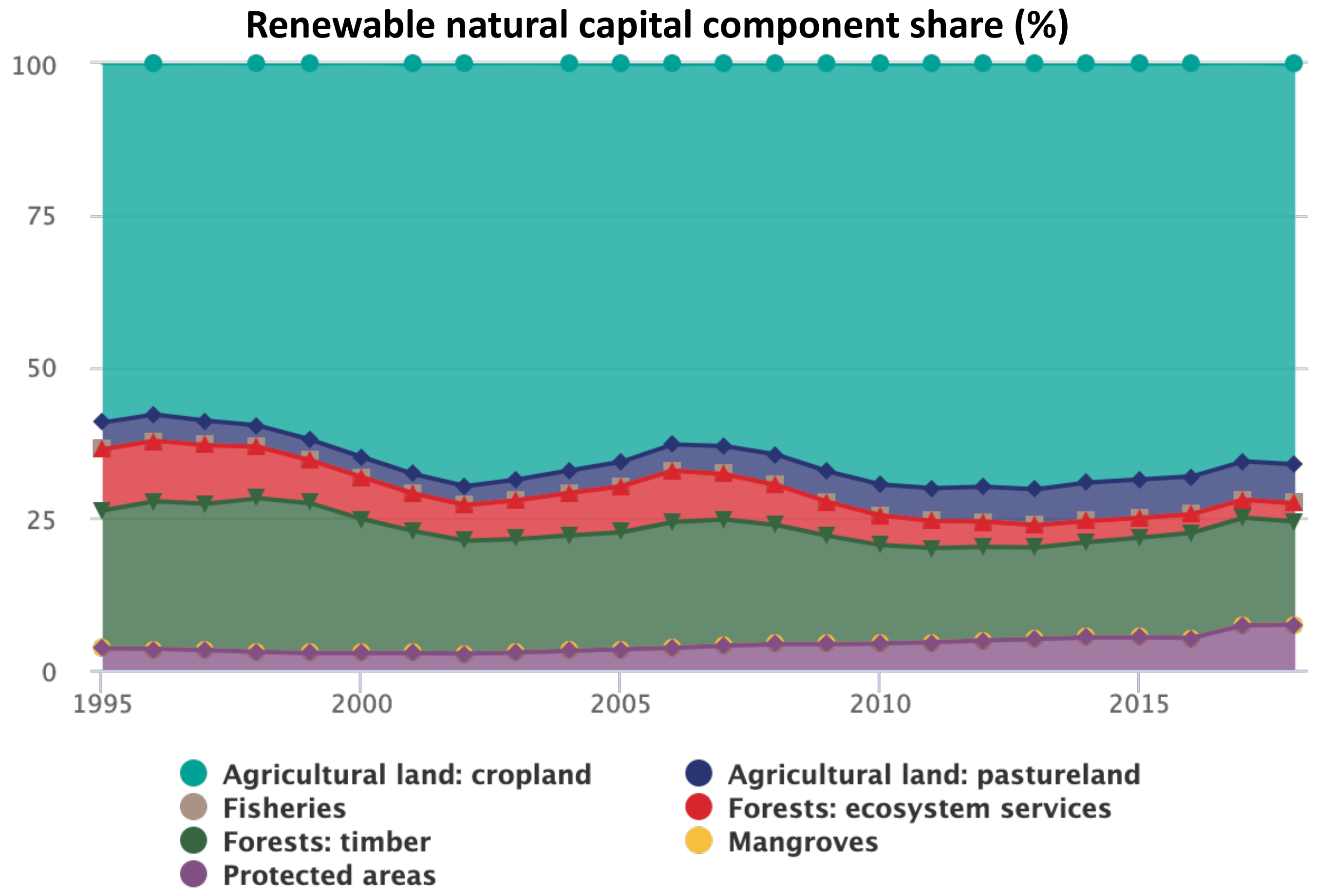
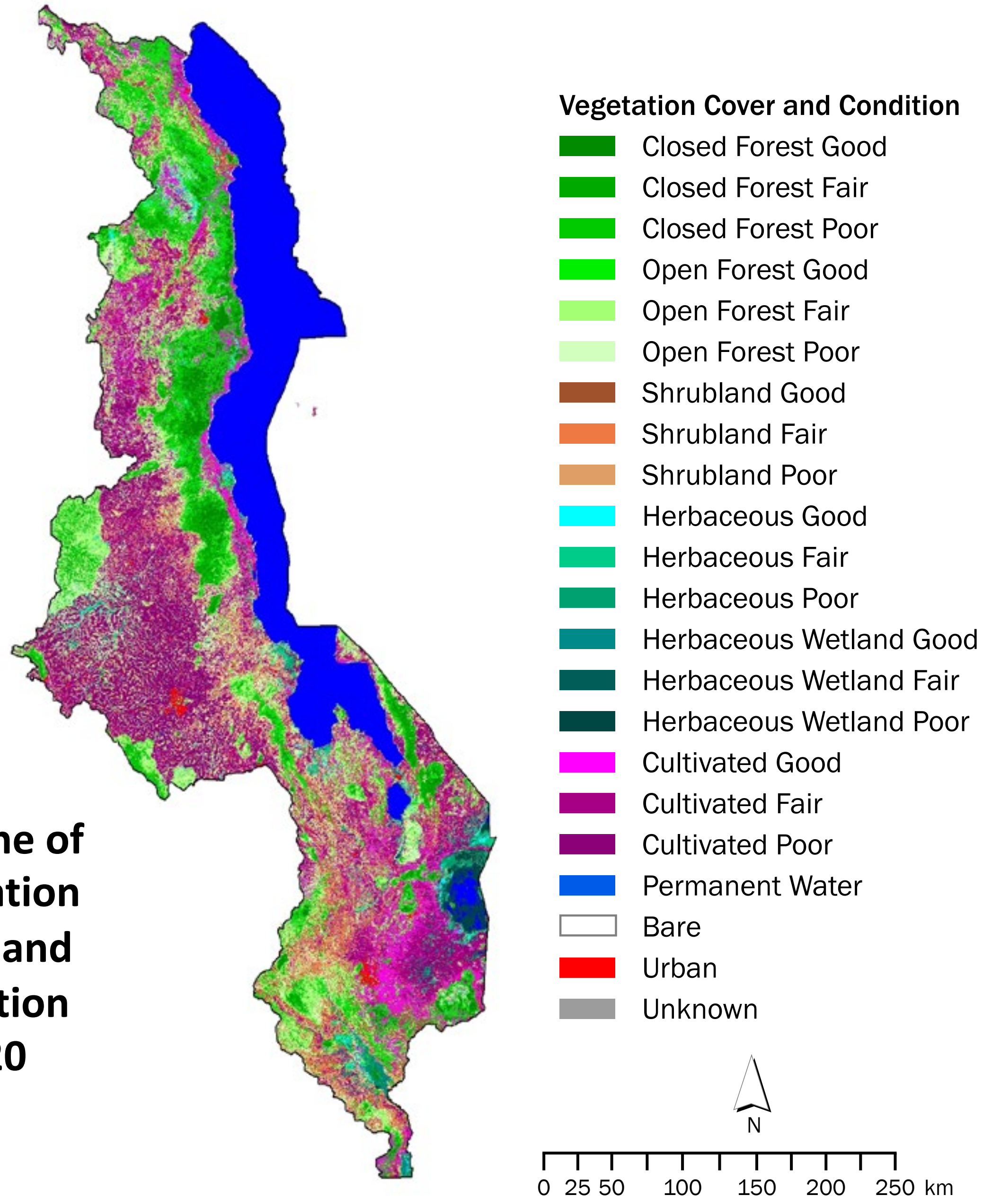
… but, this comes at a cost to Malawi's forests

- Expanding agriculture and livestock production are coming at the expense of other forms of natural capital.
- Timber share of natural capital value declined from 23 to 17%
- Protected areas increased, but the share of ecosystem services from forests declined from 10 to only 3%



Source: Changing Wealth of Nations 2021: Managing Assets for the Future report (CWON 2021). www.worldbank.org/cwon

Vegetation cover



Baseline of vegetation cover and condition 2020

Source: this study.

- Natural capital is the predominant form of wealth in Malawi, making up 52% of total wealth, double the share when compared to other low-income countries where the average share is 26% (World Bank 2021).

Image source: Malawi Country Climate and Development Report (World Bank Group 2022).

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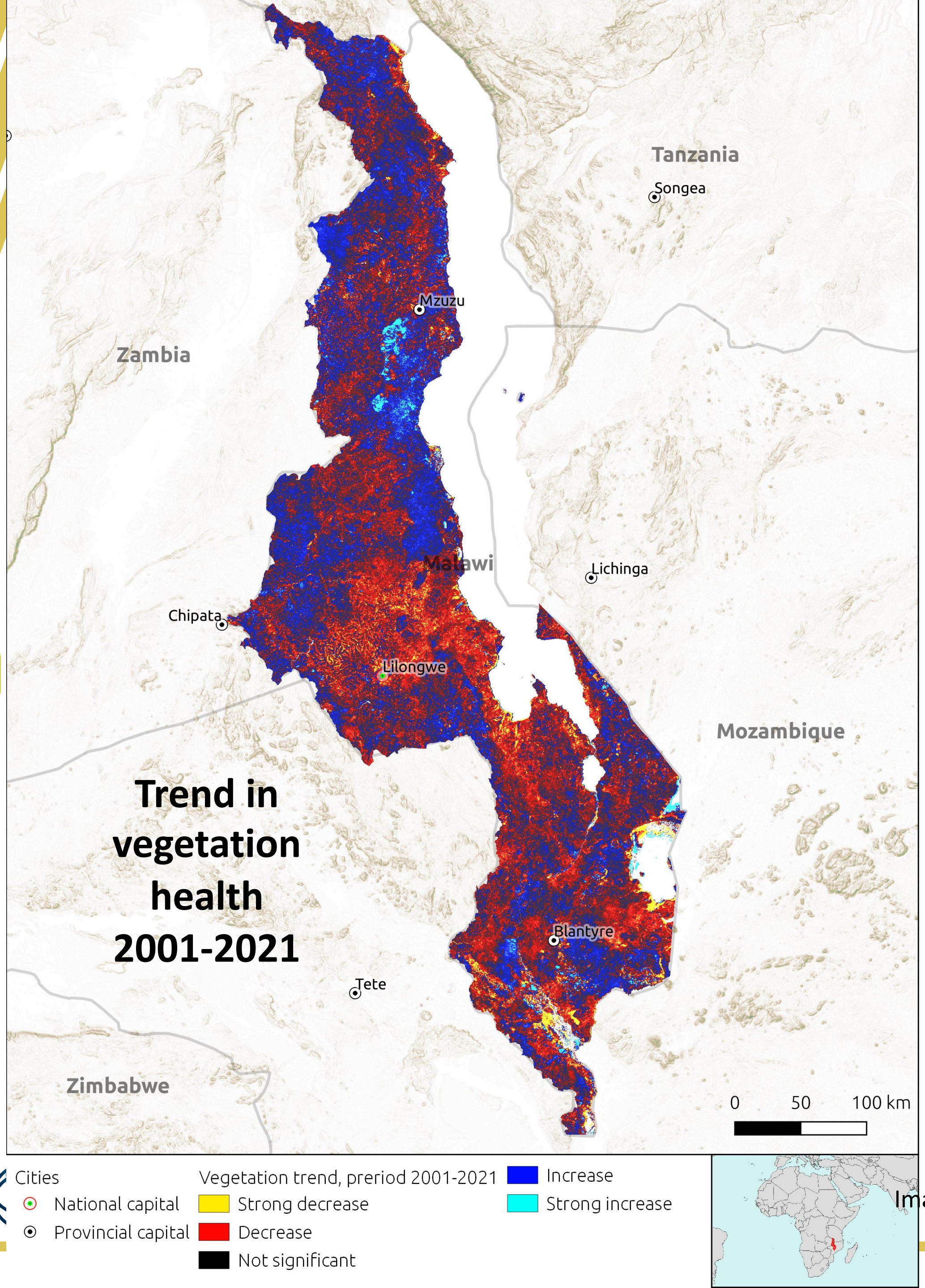
Ongoing land degradation threatens resilience

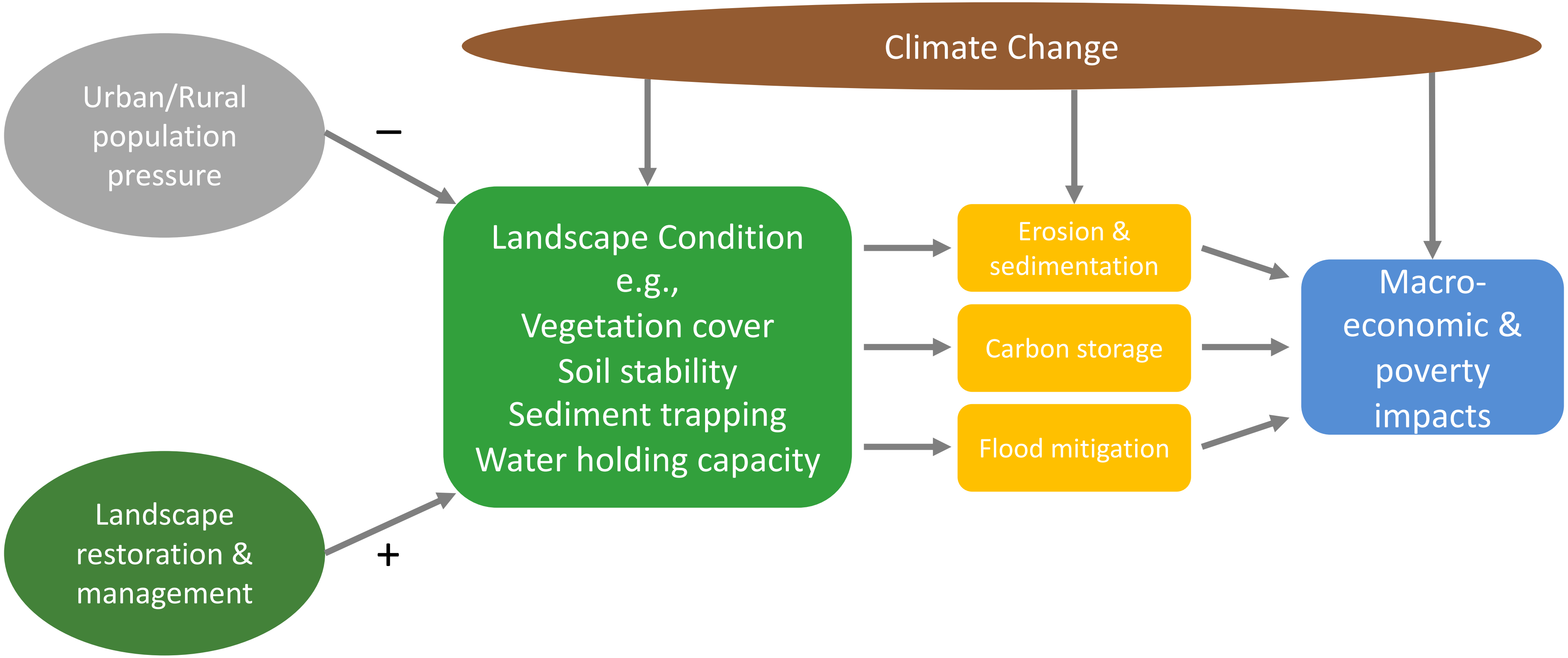


- By a recent estimate, much of the country's land area of forests, croplands, rangelands, and wetlands is degraded, imposing costs on economic growth, impairing vital ecosystem services, and reducing climate resilience.

Image source: Malawi Country Climate and Development Report (World Bank Group 2022).


Food, fuel, fiber
Soil retention
Climate regulation
Water regulation
Landslide/ flood mitigation
Biodiversity

Ecosystem services depend on landscapes in good condition



Objectives of the report

(1) select a representative set of climate scenarios that will be used to assess the macroeconomic effects of climate change;

(2) conduct deep dive analyses focused on the agriculture, water, energy, and infrastructure sectors;

(3) evaluate the impacts of land management investments on these sectors; and,

(4) develop macroeconomic shocks arising from multiple impact channels under climate change.

11 impact channels

Impact Channels and Adaptation Actions Modeled

Channel of impact	Description	Adaptation
Labor productivity		
Heat stress	Shock to sectoral labor productivity due to shocks from heat stress, estimated from temperature and humidity. Considers sector-specific work ability curves from heat stress.	Not considered
Human health	Shock to total labor productivity from increased morbidity of vector-borne and temperature-related diseases.	Not considered
Land management		
Carbon storage	Change in total terrestrial carbon storage. Considers changes in vegetation type and degradation due to population pressure on natural resources, and the benefits of investing in restoration, conservation agriculture, agroforestry, etc.	Landscape restoration
Erosion and sedimentation	Impacts of landscape degradation on erosion in croplands and on sedimentation to major reservoirs.	Landscape restoration
Energy, water, and agriculture		
Hydropower	Impacts on energy generation resulting from changes in river runoff.	Investments in transmission and resilient hydropower plants
Irrigated and Rain Fed Crops	Shock to crop revenues. Based on yield responses to water availability, erosion, and heat tolerance.	Irrigation efficiency, switch to climate resilient crops
Livestock yields	Shock to livestock revenues. Based on availability of feed from pastures and heat stress impacts on livestock productivity.	Investment in alternative feed sources
Water supply and sanitation	Shock to labor supply and productivity and health care expenditures.	Not applicable
Infrastructure		
Inland flooding	Capital damages from precipitation changes, considering floodplains, design flood events, and spatial distribution of capital. Building on outputs from land management model.	Landscape restoration and flood-resilient infrastructure
Urban flooding	Shock to capital stock and land from changes in the recurrence of flood events. Considers built-up capital, agricultural capital, and agricultural land.	Improved infrastructure to withstand higher flood depths
Roads and bridges	Shock to capital stock due to temperature, precipitation, and flooding effects across paved, gravel, and dirt roads.	Investment in climate-proof infrastructure

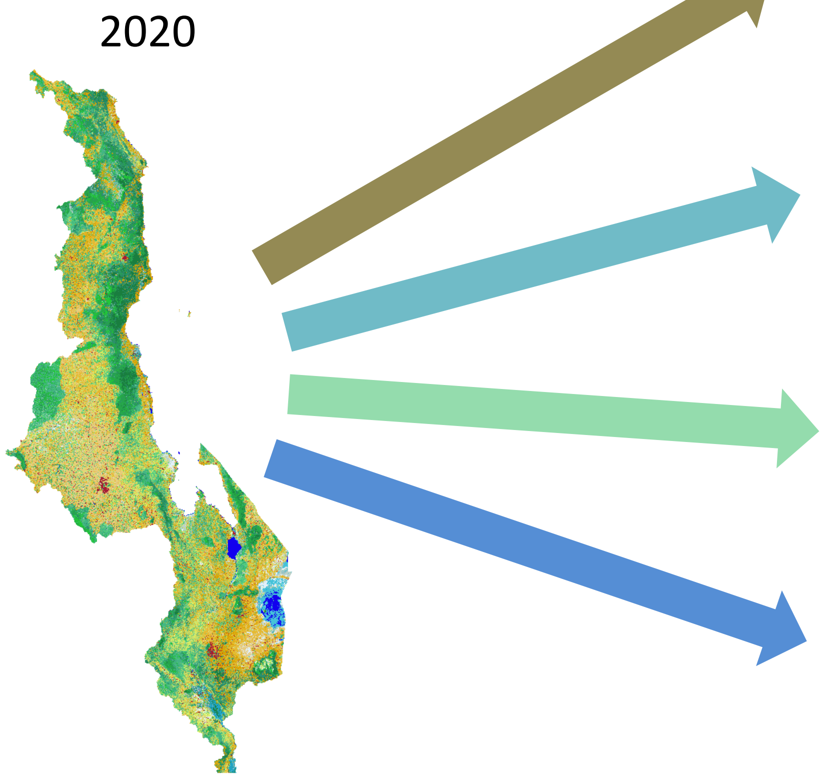
5 climate scenarios

Dry SSP-119. *"Dry" scenario that is 10th percentile of mean* ***precipitation*** *change across* ***SSP1-1.9 GCMs***
Wet SSP-119. *"Wet" scenario that is 90th percentile of mean* ***precipitation*** *change across* ***SSP1-1.9 GCMs***
Dry SSP-370. *"Dry" scenario that is 10th percentile of mean* ***precipitation*** *change across* ***SSP3-7.0 GCMs***
Wet SSP-370. *"Wet" scenario that is 90th percentile of mean* ***precipitation*** *change across* ***SSP3-7.0 GCMs***
Hot SSP-370. *"Hot" scenario that is 90th percentile of mean* ***temperature*** *change across* ***SSP3-7.0 GCMs***

SSP1-1.9: The IPCC's most optimistic scenario, this describes a world where global CO2 emissions are cut to net zero around 2050. Societies switch to more sustainable practices, with focus shifting from economic growth to overall well-being. Investments in education and health go up. Inequality falls. Warming hitting 1.5C but then dipping back down and stabilizing around 1.4C by the end of the century. Extreme weather is more common, but the world has avoided the worst impacts of climate change.

SSP3-7.0: On this path, emissions and temperatures rise steadily and CO2 emissions roughly double from current levels by 2100. Countries become more competitive with one another, shifting toward national security and ensuring their own food supplies. By the end of the century, average temperatures have risen by 3.6C.

4 snapshots of Malawi's future



Business-as-Usual (BAU): Degradation trends continue

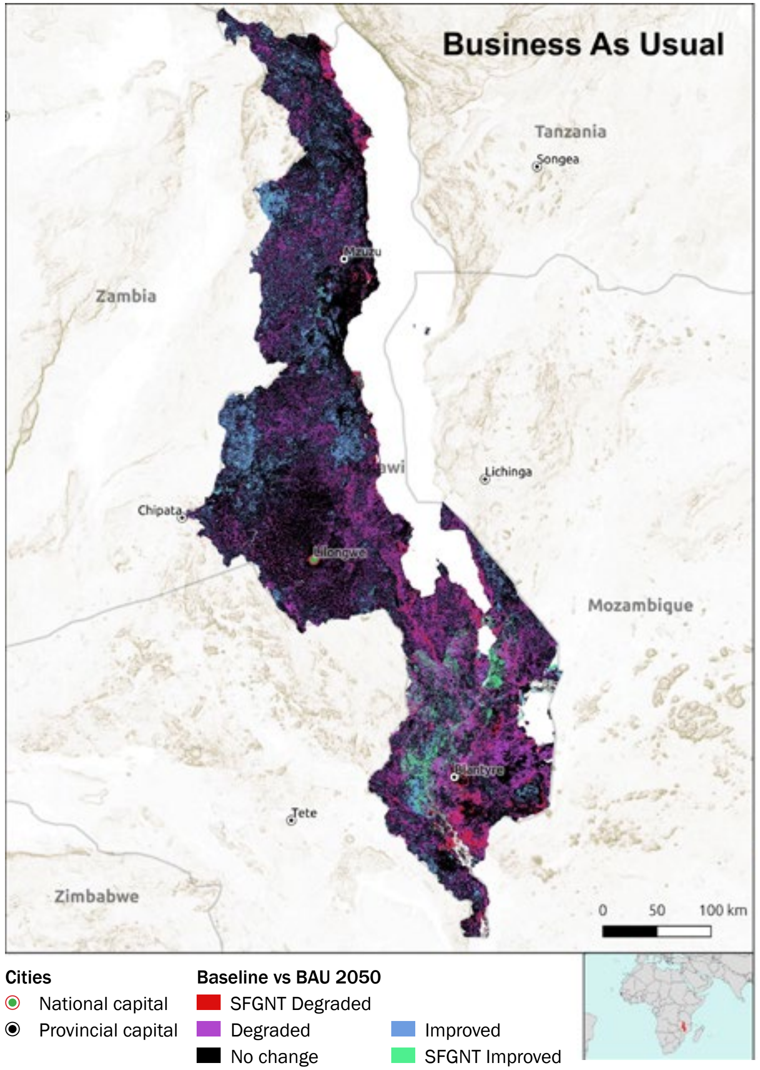
BAU + Adaptation (BAU+): NDC commitments in forest, land, wetlands

Aspirational Growth (ASP): Large-scale restoration following existing priorities

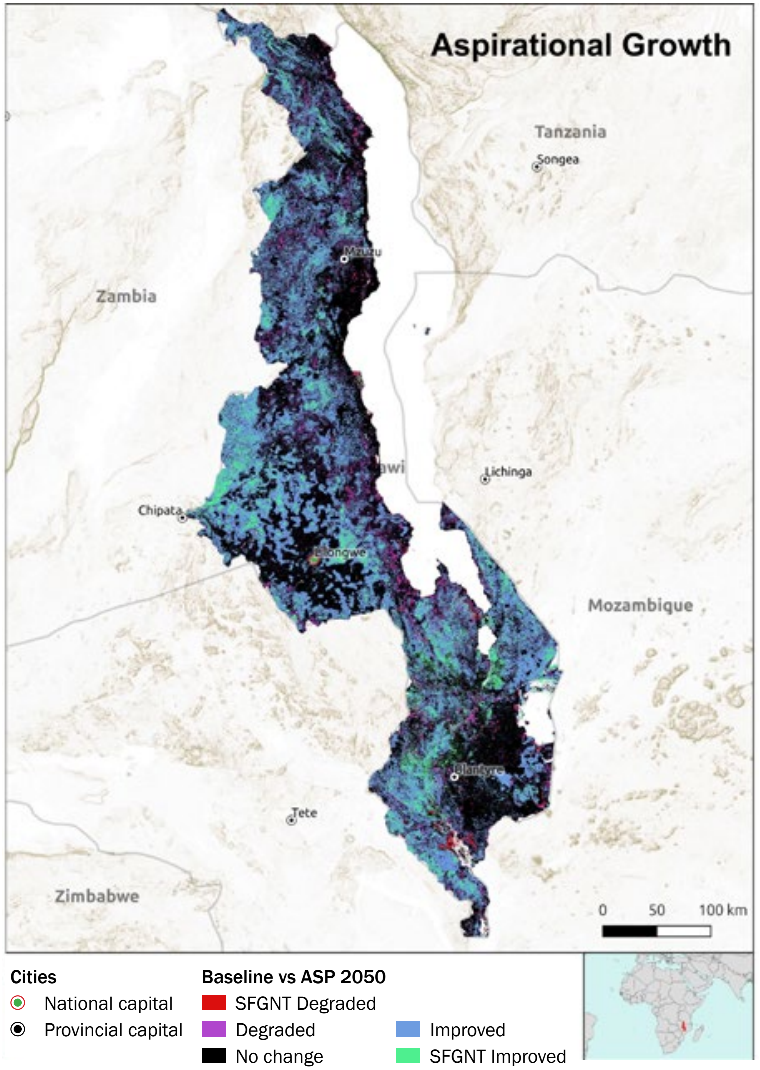
Resilient Growth (RES): Climate- and ecosystem services-oriented restoration

Scenarios: Snapshots of Malawi's future

BUSINESS AS USUAL 2050



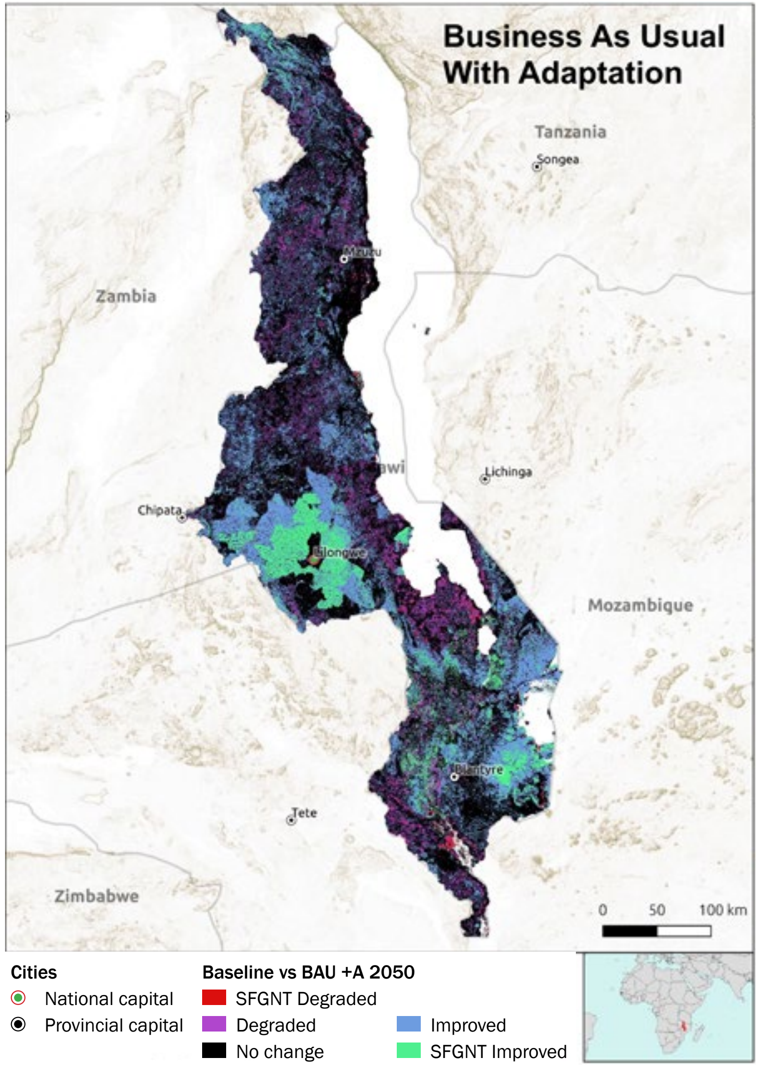
ASPIRATIONAL GROWTH 2050



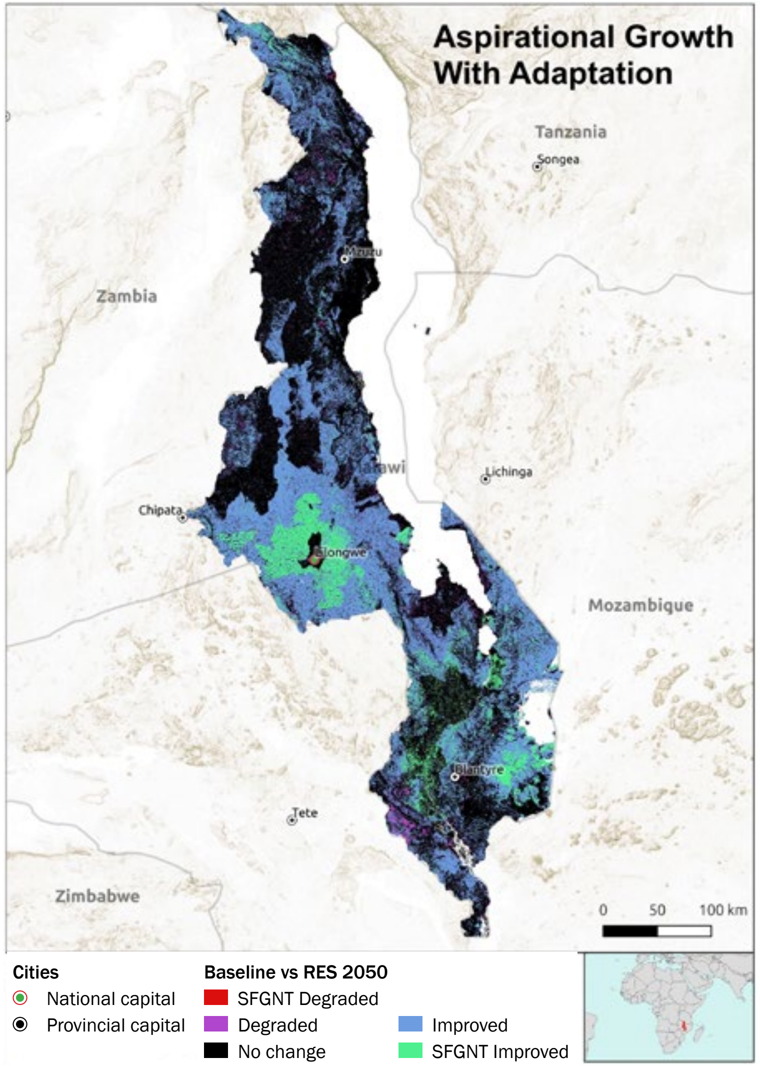
2.4M ha versus **0.67M ha** in degrading condition

Scenarios: Snapshots of Malawi's future

BAU WITH ADAPTATION 2050



RESILIENT GROWTH 2050



1.0M ha versus **0.26M ha** in degrading condition

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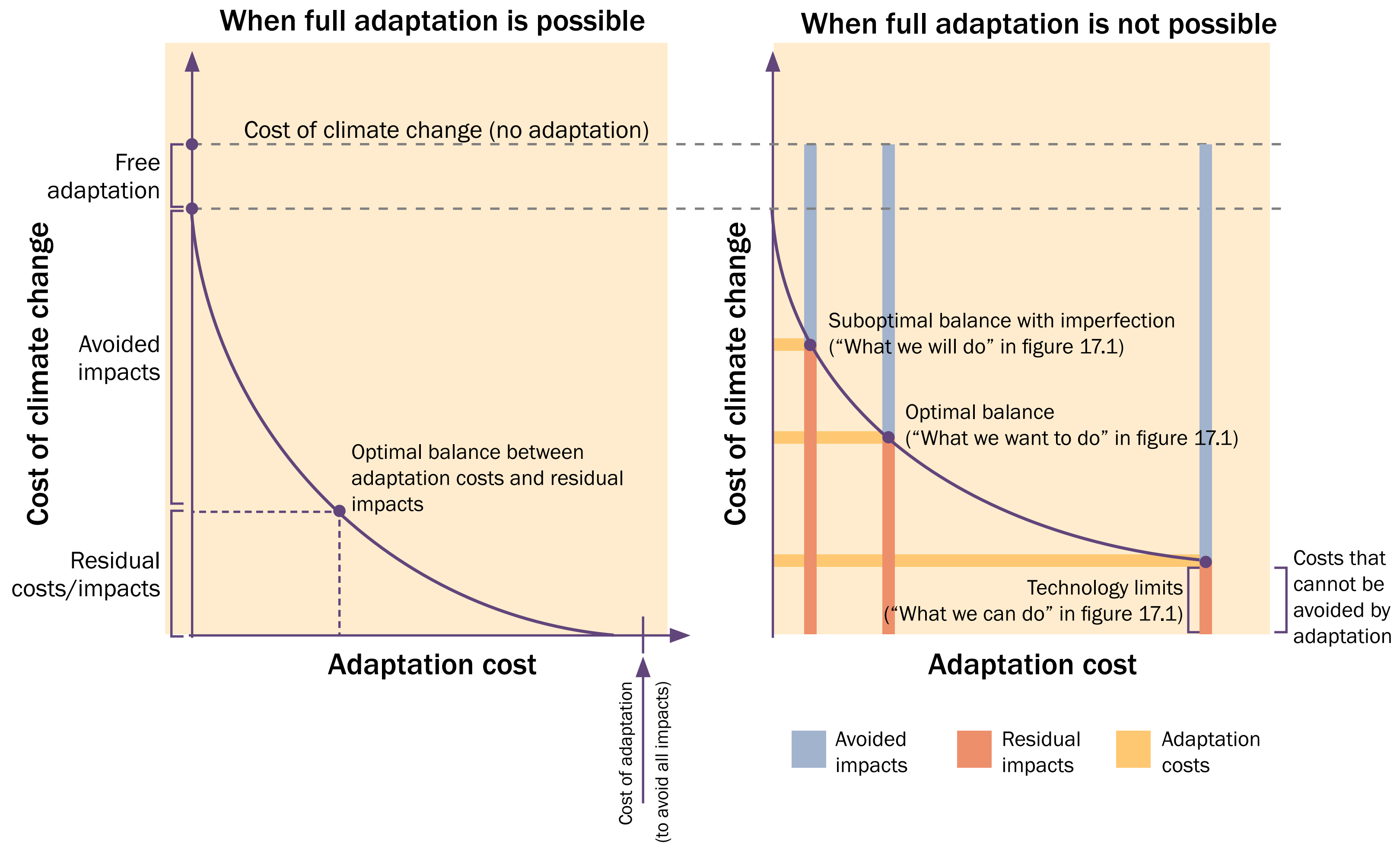
Costs of adaptation or costs of climate change

Figure 5. Representation of Adaptation Costs and Residual Costs of Climate Change



Source: IPCC (Chambwera et al. 2014)

Scenarios: Snapshots of Malawi's future

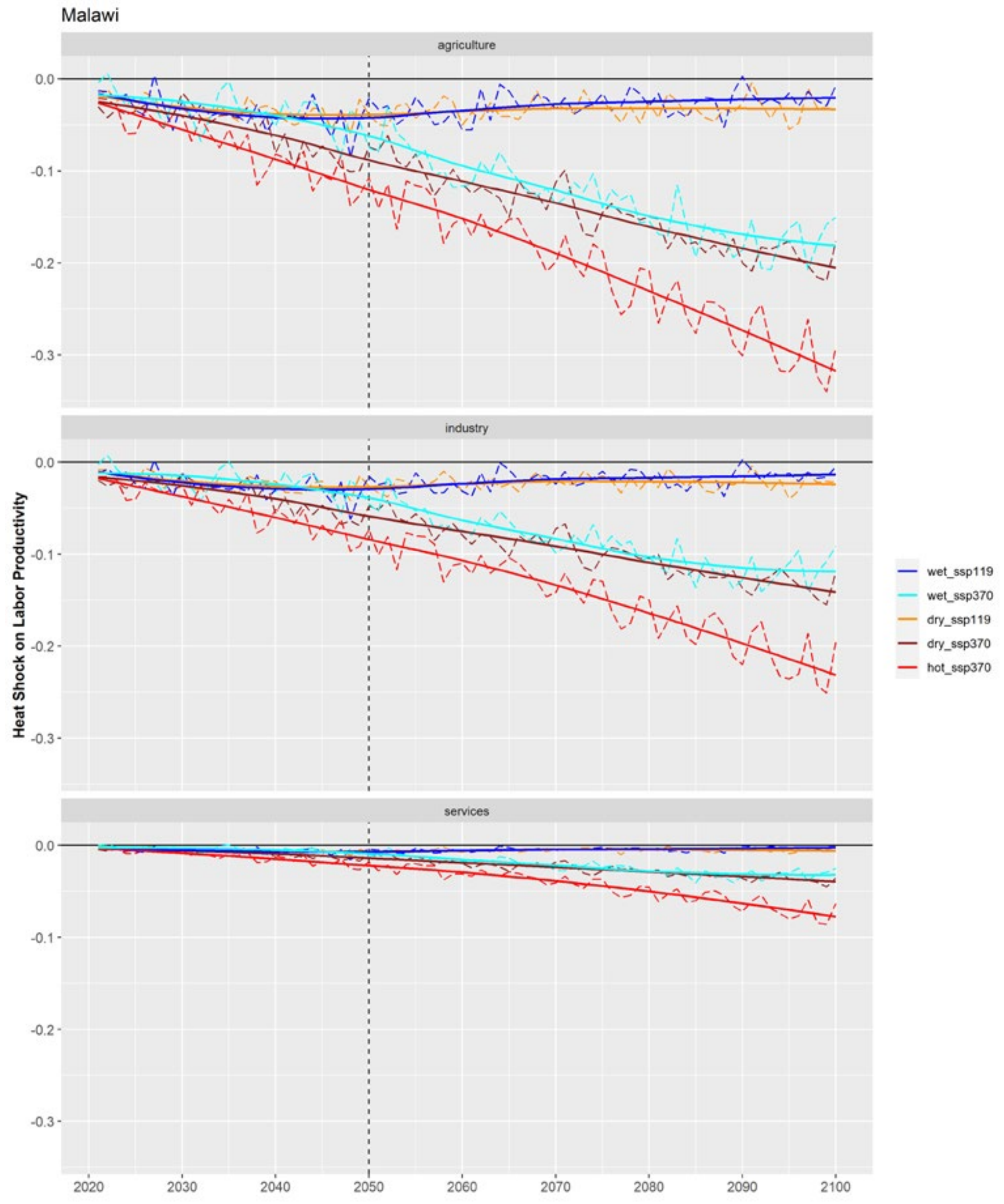
Scenario	Description	Total Area Restored (M ha)	Cost (M USD)
Business-As-Usual (BAU)	Historical degradation trends continue. Restoration limited to existing efforts under the MWASIP* project.	0.285	$262.5
BAU w/Adaptation (BAU+)	Successful implementation of the country's NDC commitments in soil & water conservation, agroforestry, conservation agriculture, forestry, and riparian restoration.	2.5	$2,400
Aspirational Growth (ASP)	Successful implementation of the country's Bonn Challenge forest landscape restoration commitment, National Charcoal Strategy and Clean Cooking Initiatives, and doubled investment in MWASIP.	4.5	$4,340
Resilient Growth (RES)	Accelerated investment in clean cooking, reducing demand for fuelwood from the landscape by 45 percent, and targeting of land restoration efforts to improve ecosystem services.	4.5	$4,619

Sectoral impacts of changes in natural capital

1 Labor productivity: **Heat stress**

- Labor productivity shocks under each of the five climate change scenarios and under each of the MFMod sectors: agriculture, industry, and services.
- Given its dependence on outdoor labor, the agricultural sector shows the largest impacts, followed by industry, then services.
- In 2050 under the hot SSP370 scenarios, impacts are as high as 12 percent, 9 percent, and 2 percent in the three sectors, respectively.

Figure 9. Labor Productivity Shocks Due to Heat



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2 Labor productivity: **Human health**

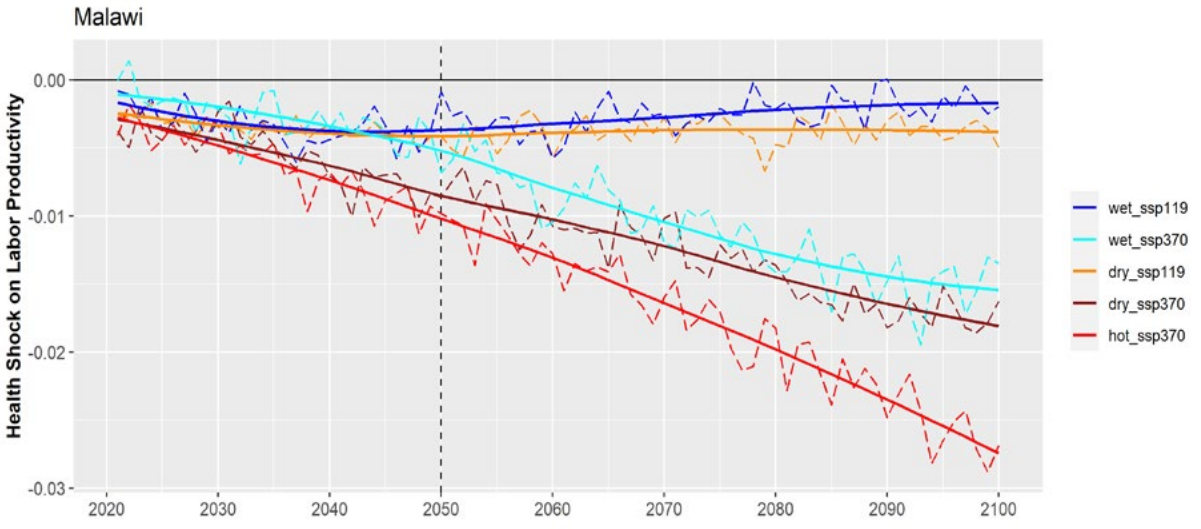
- Labor productivity shocks due to health effects under each of the five climate change scenarios.
- By 2050, labor productivity impacts reach just under 3 percent in the hot SSP370 scenario.

Table 6. Additional Years of Life Lost from 1°C Warming

Disease	Africa	Malawi
Malaria	310	4
Dengue	0.02	0.005
Diarrhea	834	9
Respiratory and cardiovascular	3,744	53
% increase	**.30**	**.32**

Notes: YLLs represent the average between 2010-2019

Figure 10. Labor Productivity Shocks Due to Health Effects



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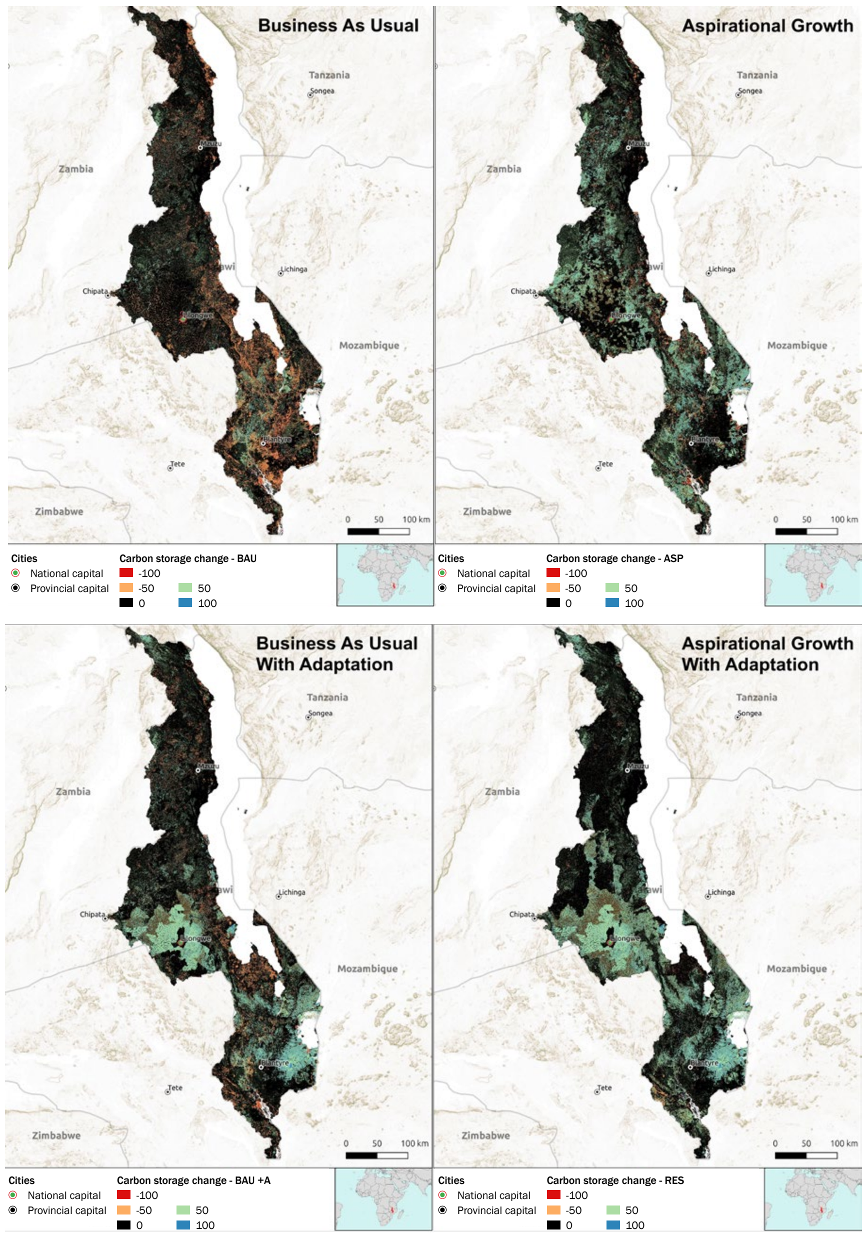
3 Land management: **Carbon storage**

Scenario	Total value by 2050, M USD (low to high estimate)	Annual value, M USD (low to high estimate)
BAU	**-287** (-144 to -431)	**-9.6** (-4.8 to -14.4)
BAU+ (w/adaptation)	**955** (478 to 1,433)	**31.8** (15.9 to 47.8)
ASP	**1,100** (550 to 1,650)	**36.7** (18.3 to 55.0)
RES	**1,486** (743 to 2,228)	**49.5** (24.8 to 74.3)

- Emissions, relative to baseline 2020, would increase 28.72 Mt CO_2e under the BAU scenario.
- Emissions, relative to baseline 2020, can reduce in up to 148.55 Mt CO_2e in the RES scenario.

Figure 14. Change in Land-Based Storage of CO2e (Mg/Ha) in 2050 Relative to Baseline



4 Land management:
Erosion & sedimentation

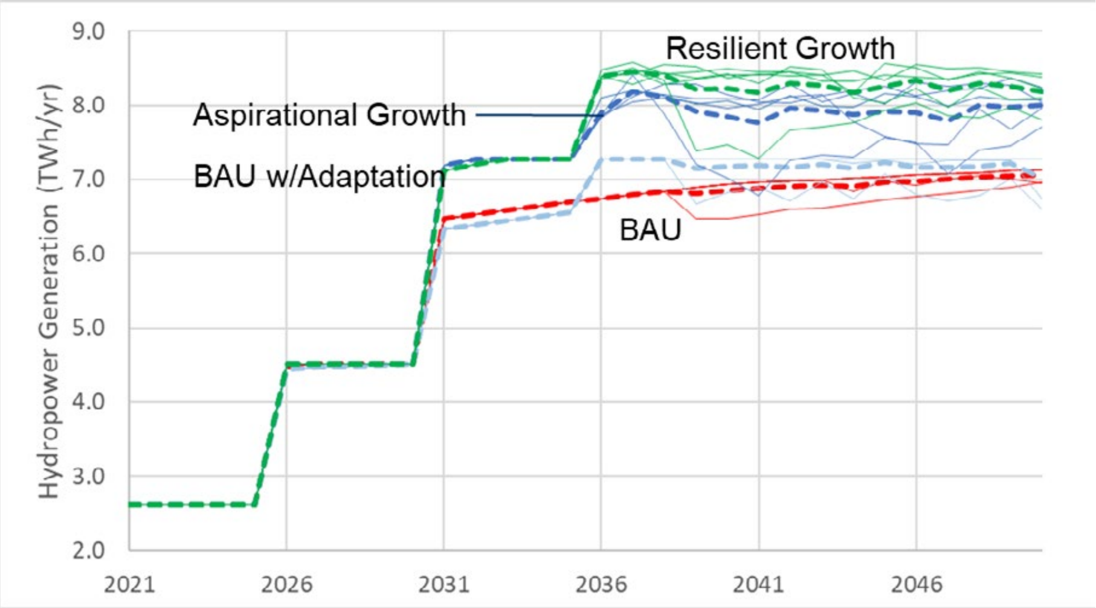
- Climate change plus land degradation in the BAU scenario could result in increased soil losses of up to 9 tons/ha/yr in croplands.
- Improved land management can offset and further reduce erosion losses by 12 to 19 tons/ha/yr.

Summary: Sedimentation	
Output	Range of mean annual erosion in croplands (t/ha/yr) under different scenarios of climate change
Results by 2050	BAU: 37 – 42 ASP: 24 – 28 BAU+: 25 – 28 RES: 21 – 24
Output	Range of annual sedimentation in reservoirs (Million t/yr) under different scenarios of climate change
Results by 2050	BAU: 3.7 – 4.7 ASP: 2.3 – 2.9 BAU+: 2.2 – 2.9 RES: 1.8 – 2.2

5 Energy, water and agriculture: **Hydropower**

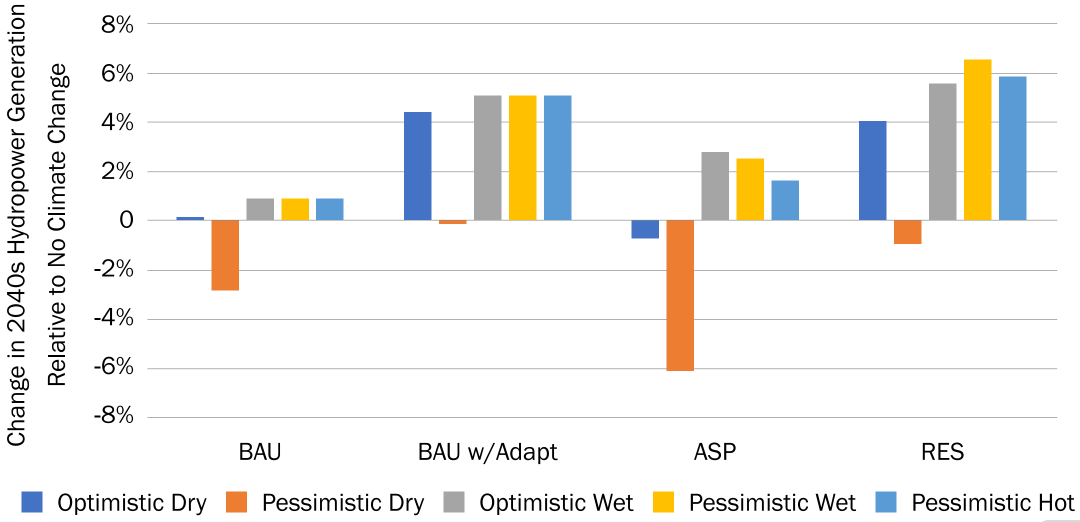
- Overall, the impact of climate change on Malawi's hydropower generation is relatively low.
- Hydropower production in Malawi is found less sensitive to climate than in Mozambique, because the turbinating capacity of the hydropower plants is designed for an average flow that is lower than the observed flow, and because the new dam in Liwonde is able to regulate releases out of Lake Malawi.

Figure 17. Annual Hydropower Generation Under Policy Scenarios



Notes: Dashed line is average across climate scenarios

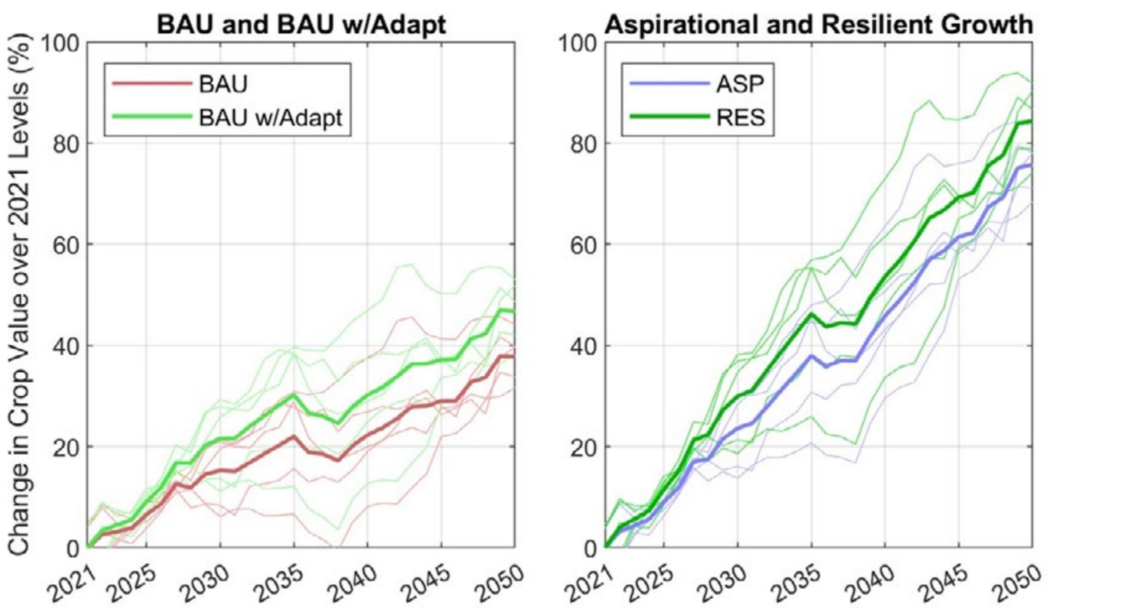
Figure 18. Hydropower Generation Shock in 2040s Relative to No Climate Change



6 Energy, water and agriculture: **Irrigated and rain fed crops**

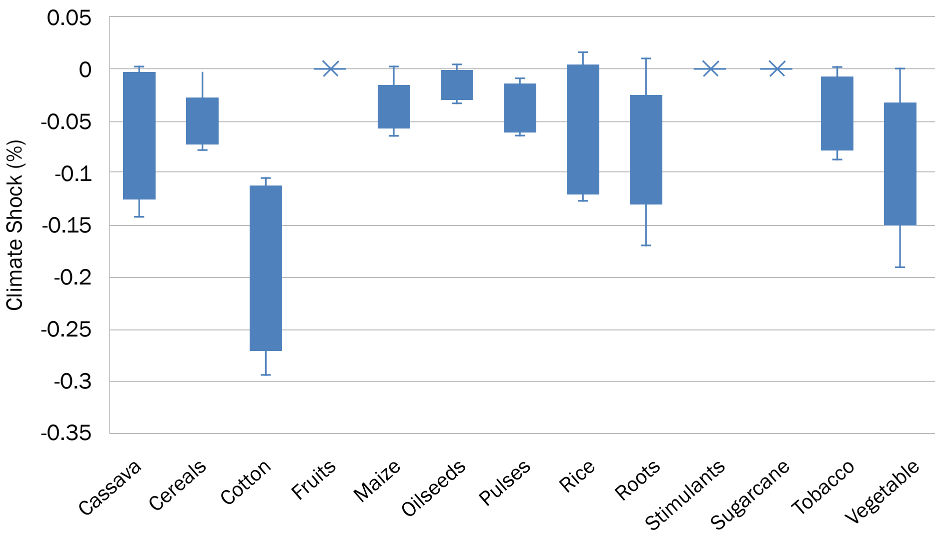
- With adaptation, crop values could increase up to 18% between 2021-2035 and 30% between 2036-2050 in a Resilient Growth scenario versus BAU compared to historical yields.
- Resilience can be enhanced through a combination of actions including land management, crop switching, and higher irrigation efficiency.
- While improving yields does not mitigate the effects of climate change on relative yields, it does ensure that absolute production and revenues do not decrease in the future.

Figure 19. Crop Value Shock Relative to 2021



Notes: Bold line represent average of five climate projections, thinner lines represent 10-year moving averages of individual GCM runs.

Figure 20. Climate Sensitivity of Different Crop Yields for the BAU Scenario



7 Energy, water and agriculture: **Livestock yields**

- Impacts are lower in the near term, but damages to the livestock sector could become much larger by late century.
- The hot and pessimistic dry scenarios show the largest declines in livestock production, particularly after 2050 when yields fall considerably due to rising temperatures and increased aridity.

Figure 22. Livestock Revenue Shocks

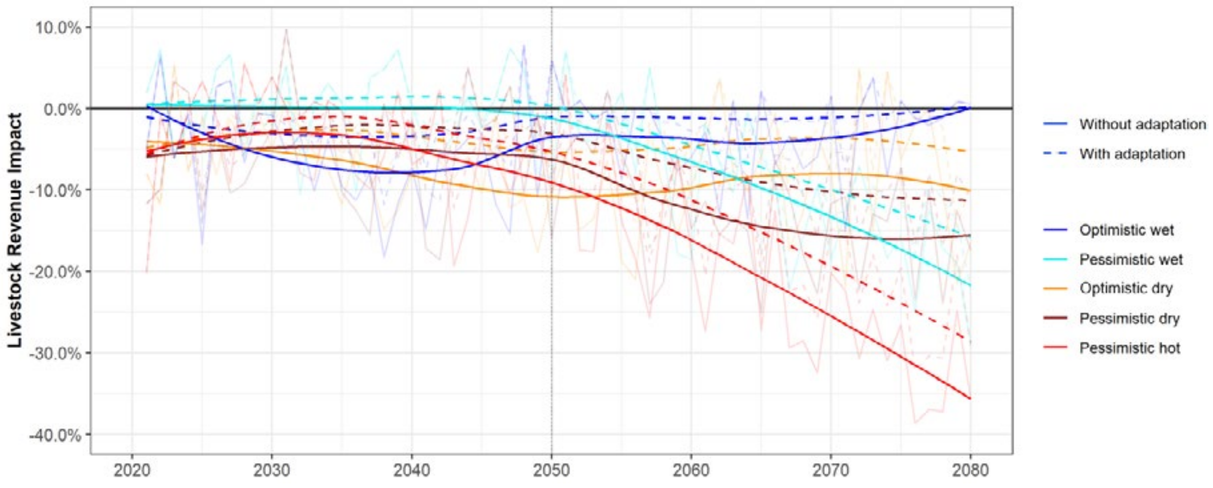


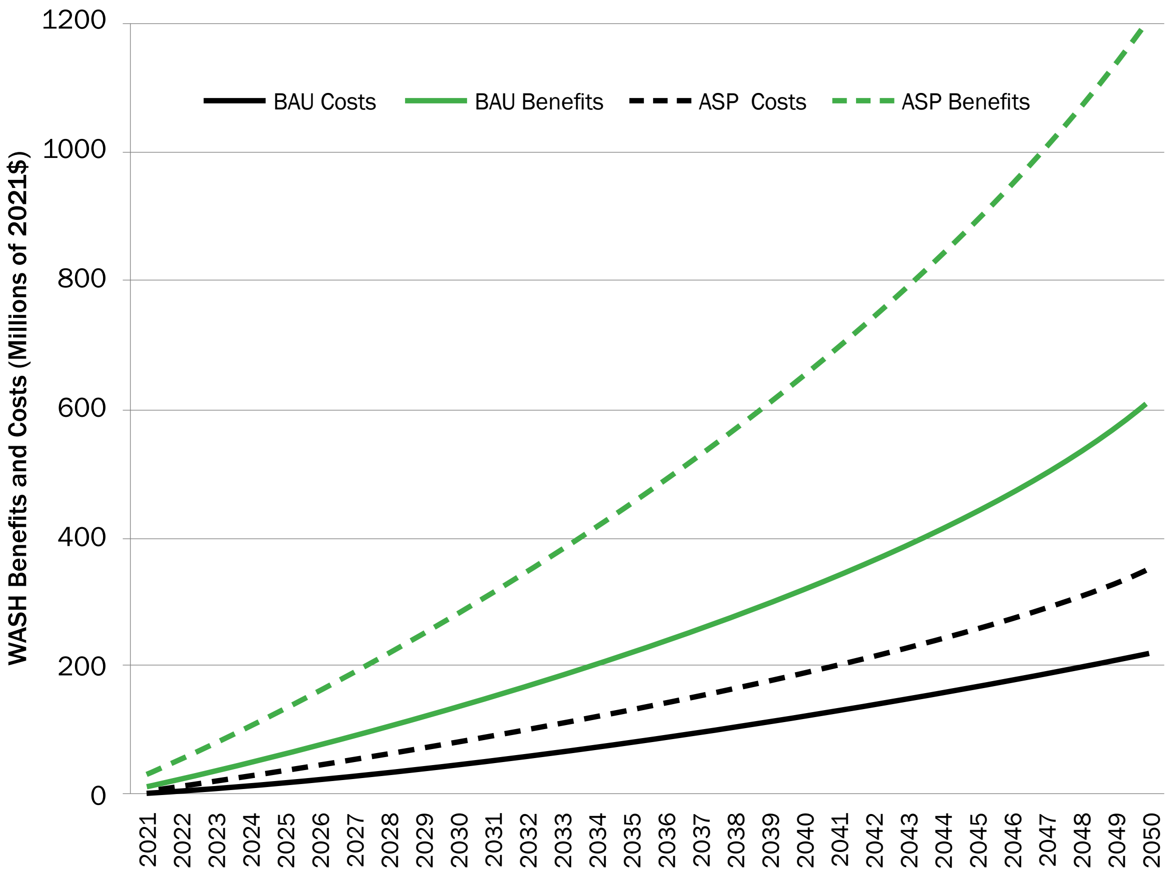
Table 16. Change in Livestock Revenues between 2041-2060, Relative to Baseline

Values	Optimistic wet	Pessimistic wet	Optimistic dry	Pessimistic dry	Pessimistic hot
Without adaptation	-4.2%	-3.1%	-10.3%	-8.0%	-9.9%
With adaptation	-1.5%	-1.1%	-5.0%	-4.3%	-6.1%

8 Energy, water and agriculture:
Water supply and sanitation

- Every US$1 of spending on WASH coverage yields approximately US$3 in benefits.
- Total benefits can reach US$600 and US$1,200 million by 2050 under BAU and ASP respectively.
- Total annual net benefits (that is, benefits minus costs) under ASP are US$850 million versus US$380 million under BAU.

Figure 25. WASH Investments Benefits and Costs [Millions of 2021$]



9 Infrastructure: **Inland flooding**

- Continued land degradation would increase the damage to infrastructure from inland flooding by as much as 25 percent by 2050.
- A strong commitment to landscape restoration (as seen in the ASP and RES scenarios) can reduce future losses by 50 percent and more by mid-century, even resulting in positive gains under an optimistic climate.

Figure 27. Illustrative Example of the Resolution of the Flooding Analysis in the Salima District

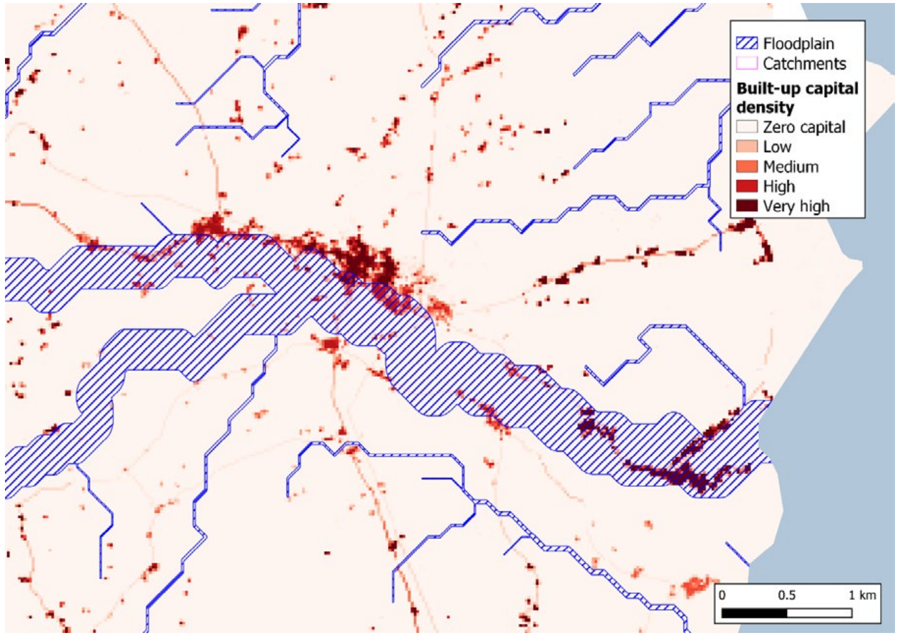
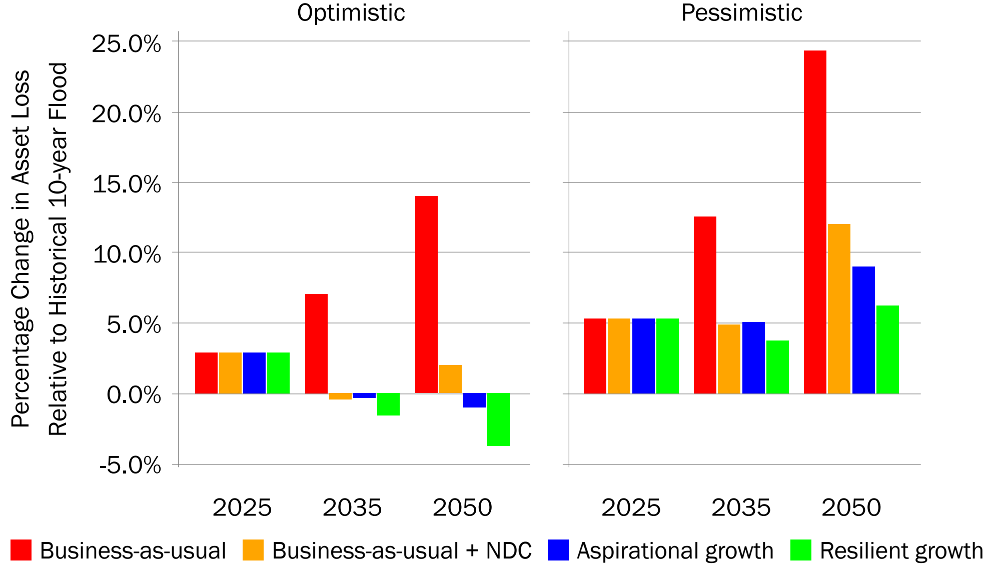


Figure 29. Increase in Built-Up Capital Asset Loss Resulting from A 10-Year Flood

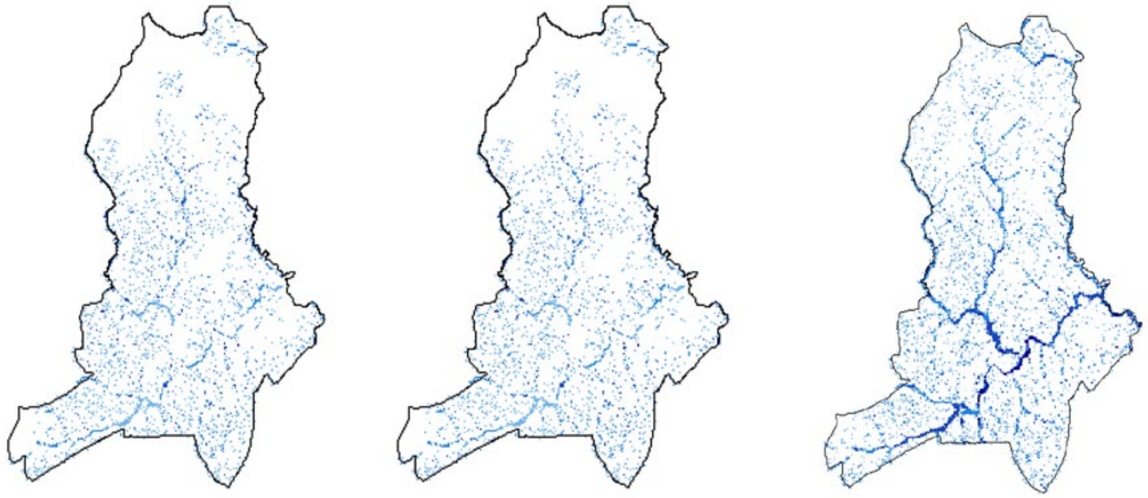


10 Infrastructure: Urban flooding

- The climate effects on urban flooding are quite modest, with only a 4 percent and 2 percent increase in flood damage by 2050 in Lilongwe and Blantyre, respectively, under the pessimistic climate scenario.

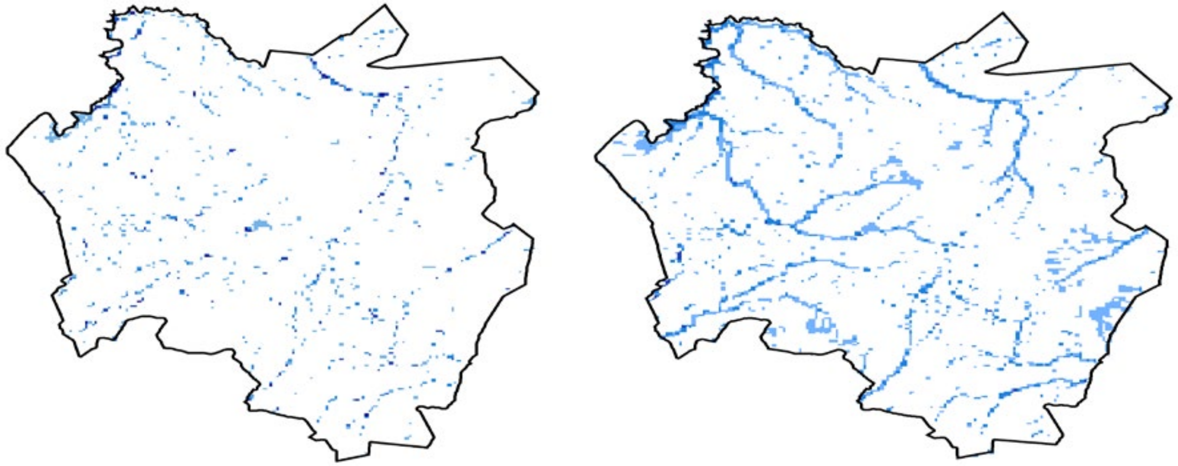
- Considering urban area growth in Lilongwe, the 2050 scenario shows a notable change in the total damage values, roughly four times baseline, indicating more uncertainty in urban growth than in variability across climate models.

Figure 30. Flood Inundation Results for Lilongwe for 50 (left), 100 (center), and 250 mm (right) Storms



Note: corresponding to BAU 2050 Urban Land use expansion

Figure 32. Flood Inundation Results for Lilongwe for 100 (left) and 450 mm (right) Storms

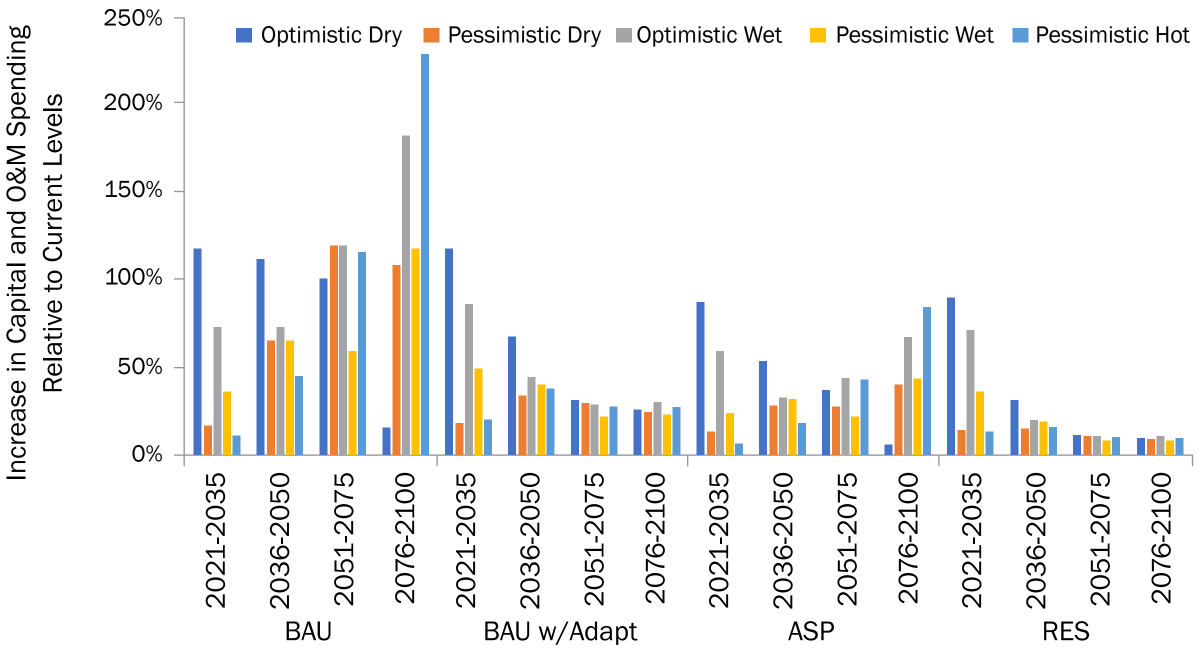


Note: corresponding to BAU 2050 Urban Land use expansion

11 Infrastructure: **Roads & bridges**

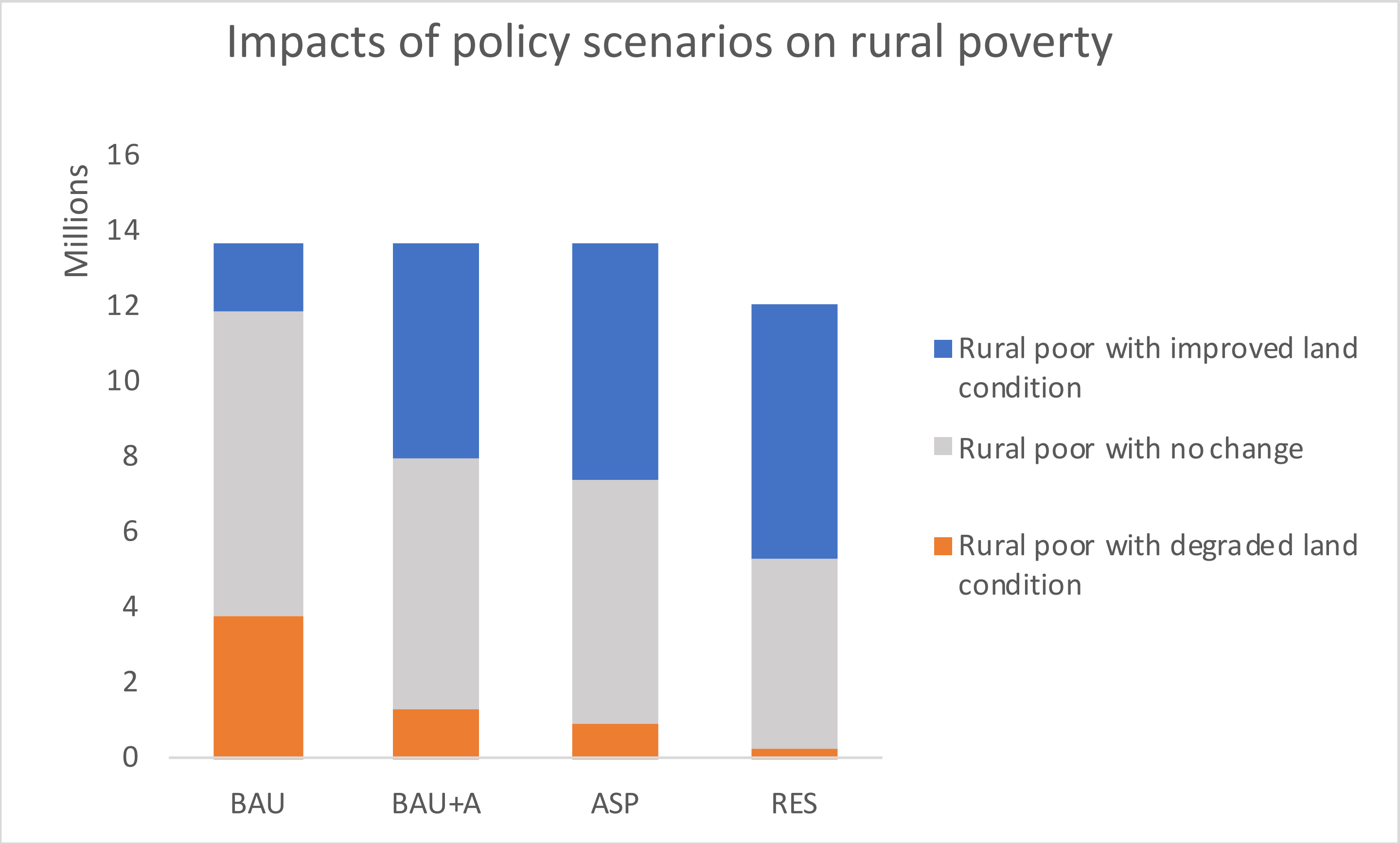
- Baseline capital and operation & maintenance spending is approximately US$100M per year.
- Under BAU, these costs can increase between 50% and over 100% by 2050 for most climate scenarios. By 2100, it can rise above 200%.
- Aspirational growth shows higher spending than BAU+ and RES to medium-term damages. Yet this trajectory does avoid significant damages towards late century.
- A resilient growth scenario that includes adaptation (RES) could bring down incremental costs to nearly zero.

Figure 35. Increase in Capital and O&M Spending due to Climate Change, Relative to Historical Spending



Where to invest in improving Malawi's natural capital?

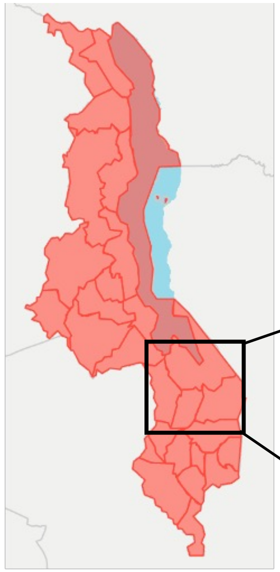
Poverty



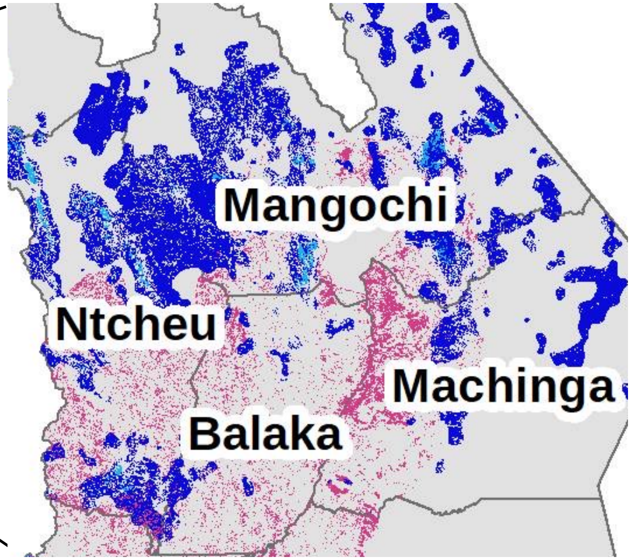
- Improved land condition can enhance climate resilience for rural persons living in poverty.
- Continued land degradation would increase the number of rural poor living on degraded land to over 3.7M, adding to climate vulnerability.
- A strong commitment to landscape restoration can reduce this number 10x, and improve land condition for over 6.7M people living in poverty.

Benefits of ecosystem-based landscape assessment for designing projects

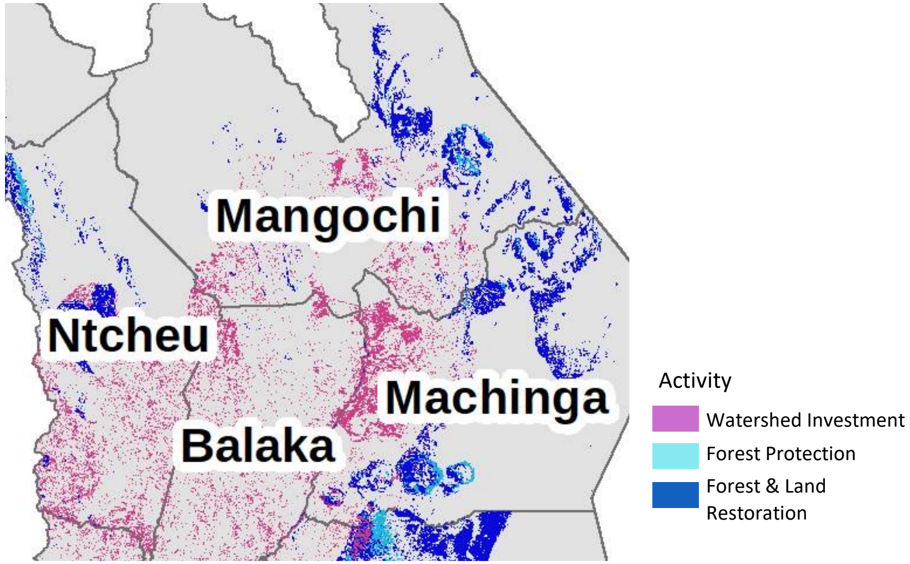
- Moving from problem-based to solution-based targeting makes investments more **effective** and **sustainable**



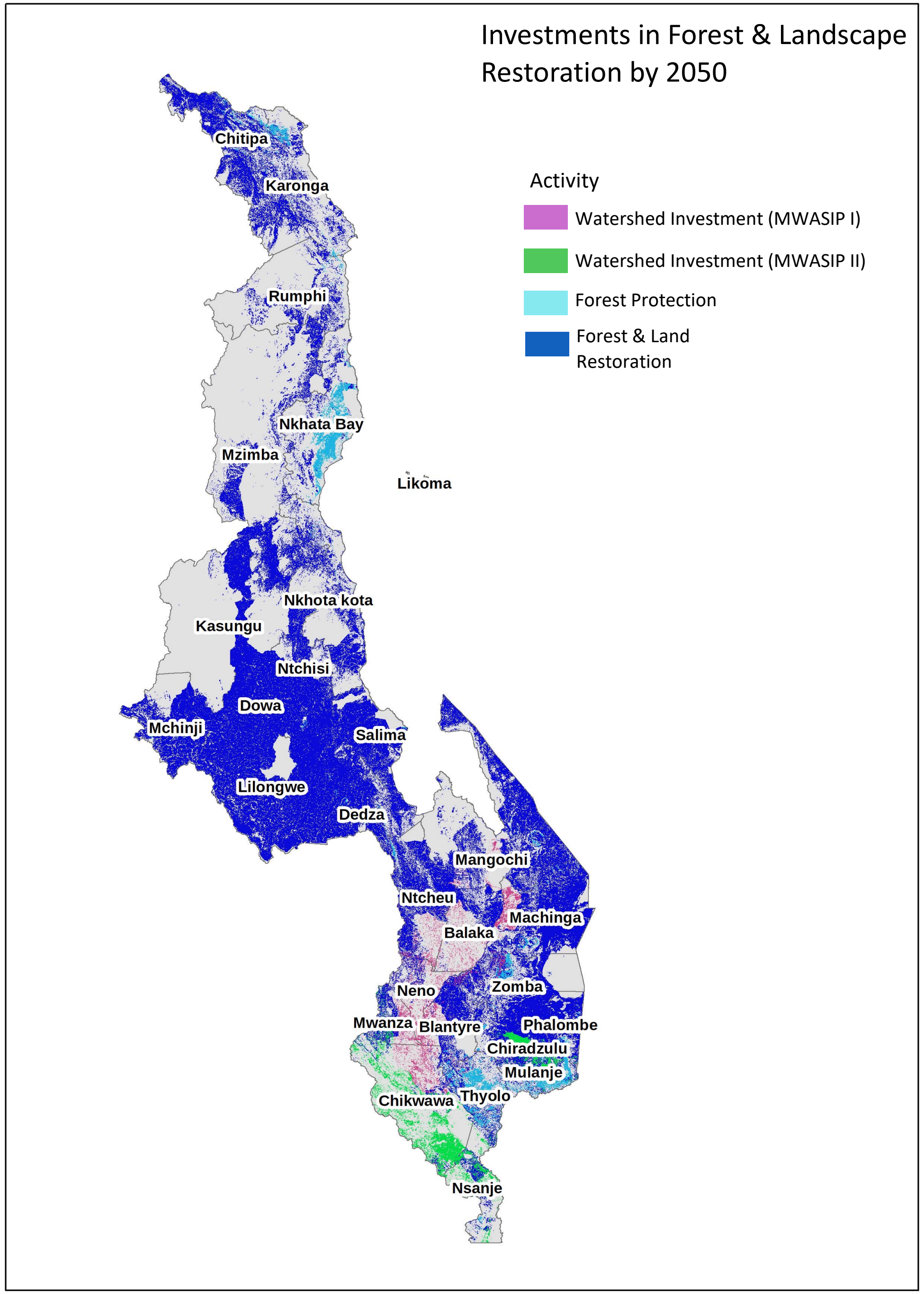
Problem-based
Targeted to degradation + erosion hazard



Solution-based
Potential to improve ecosystem services with restoration



Targeting sustainable land management in a Resilient Growth scenario



Conclusions

- Halting and reversing land degradation in the country will promote development outcomes, reduce the risk of damage to infrastructure and strengthen climate resilience.
- While the benefits of investing in natural capital take time to realize, these investments need to start now in order to see results by mid-century.
- Assessing and tracking the stocks of Malawi's natural capital through time can provide critical information to target strategic investments in land management across sectors: environment, agriculture, energy, and infrastructure.

Thank you

Questions?

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