HIGHWAY

High impact weather lake system – a proposal framework for the lake Victoria region

The Socio-Economic Benefits of the HIGHWAY project

WISER
Weather and Climate Information Services for Africa

WORLD METEOROLOGICAL ORGANIZATION

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HIGHWAY

The HIGHWAY project is being delivered by the World Meteorological Organization (WMO) working with partners including the Met Office, the National Meteorological and Hydrological Services (NMHSs) of Kenya, Rwanda, Tanzania and Uganda, the East African Community (EAC) and the Lake Victoria Basin Commission.

To find out more about the project, please visit https://www.metoffice.gov.uk/about-us/what/working-with-other-organisations/international/projects/wiser/highway

Images: I-stock. Cover: Ggaba, Uganda: Fishing boats line the banks of Lake Victoria / Tropical storm build above Lake Victoria. Inside photographs. Robert Powell.

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The HIGHWAY project is funded by WISER (Weather and Climate Information SERvices for Africa. WISER is enhancing the resilience of African people and economic development to weather related shocks. The programme aims to improve the generation and use of weather and climate information across Sub-Saharan Africa.

WISER is funded with UK aid from the British people and will deliver maximum value for money by working in partnership and collaboration, capacity building and leveraging funds to ensure long term sustainable delivery and improvement of weather and climate services for Africa.

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Summary of HIGHWAY Socio-Economic Benefits

The HIGHWAY project is integrating a regional Early Warning System (EWS) into strategies and plans on a regional, national and local scale. By doing so, it is increasing the use of weather information to improve resilience and reduce the loss of life and damage to property on and around Lake Victoria.

This investment in EWS will have large benefits in reducing the high numbers of fisherfolk and marine travellers – previously estimated at up to 3000 people per year – who drown on the lake each year.

The HIGHWAY project has estimated the socio-economic benefits (SEB) of the project activities investment on Lake Victoria. This has assessed the potential reduction in fatalities, the reduced loss of assets, as well as other benefits to various users, using a weather value chain analysis.

There are currently no accurate statistics on the numbers of drownings on the Lake – and how many of these are weather related - to allow an analysis before and after the project. The new SEB research indicates that the number of fatalities may be lower than previous studies, with an estimated 1000 weather related deaths/ year.

The SEB study has assessed the benefits of HIGHWAY along the EWS value chain using desk analysis, interviews and focus groups. This assessed the benefits from investment in infrastructure, training and science, and the improvement in weather forecasts. It has also looked at the improvements made from the project in improved communication and tailored weather information, as well as the activities to enhance its uptake and use.

The study estimates that the HIGHWAY project is leading to approximately a 30% reduction in weather related deaths on the Lake. This figure was supported by interviews and data analysis. The SEB work has also found that the improved weather information from HIGHWAY is leading to substantial fuel efficiency savings (benefits). It is also being used by fish dryers and traders to reduce weather-related losses.

The SEB study has estimated the economic benefits from the improved weather information for various user groups, created with the assistance of HIGHWAY. These benefits arise from the improved provision and use of weather forecasts and early warning information (the value of information). They cover market and non-market activities and are not restricted to purely financial benefits.

Adding these benefits together, the study estimates that the economic benefits arising from HIGHWAY activities amount to just under $50 million/year. This is extremely high when compared to the project costs (of around $5M).

The SEB study has also looked at the potential benefits from the proposed regional EWS 2025 vision. The activities proposed will reduce the current efficiency losses in the EWS value chain, and it is estimated that these would approximately double the current SEB from weather information on the Lake. It would also lead to additional benefits from the expansion of EWS to other sectors.

30%

Estimated reduction in weather-related deaths on Lake Victoria due to HIGHWAY activities

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Introduction

Lake Victoria is one of the most convectively active regions on Earth. It generates severe thunderstorms, which are an important weather hazard, with intense and often heavy rainfall, high and gusty winds, high waves, lightning and hailstorms, and water spouts on the lake. High winds also create rough water and dangerous conditions for navigation (when thunderstorms are not present), and are a major source of boat accidents and fatalities (Powell, 2016). These pose a major threat to fisherfolk, as well as passengers on small boats, and there are a large number of drownings on the lake each year.

While accurate statistics are not available, studies estimate that between 3,000 and 5,000 people die each year (IFRC, 2014). Detailed surveys in Uganda in lakeside communities (Kobusingye et al., 2016) report a drowning fatality rate of 502 deaths per 100,000 population, which is extremely high. It is not known exactly how many of these are due to the weather. However, surveys by Tushemereirwe et al. (2017) – also in Uganda – found that over 50% of respondents were aware of at least one community member who had been injured due to lightning on the lake and a third (33%) knew at least one community member who had drowned on the lake.

Adverse weather conditions also disrupt the navigation of larger transport vessels and occasionally lead to fatal accidents. Heavy rainfall often causes flooding onshore in lakeside communities. These adverse conditions will be affected by future climate change, potentially increasing risks, though the exact changes are complex and uncertain (Thiery et al., 2016).

Against this background, the goal of the HIGHWAY project (HIGH impact Weather lAke sYstem – a proposal framework for the Lake Victoria region) – is to deliver the provision of regular weather forecasts and severe weather warnings for fishing boats and small transport vessels on Lake Victoria. These new services will increase the use of weather information to improve resilience and reduce the loss of life and damage to property on and around the Lake.

Lake Victoria

Lake Victoria is the world's second largest body of fresh water by surface area. It is located in East Africa, and bordered by Uganda, Kenya and Tanzania. However, it is part of a larger watershed region which includes Burundi and Rwanda.

The Lake is extremely large but relatively shallow. It has a maximum depth of just over 80 m and the average depth is about 40 m. The shore line is approximately 3500 km.

Lake Victoria supports Africa's largest inland fishery and produces about one million tons of fish annually. Approximately 217,000 fishermen (109,000 in Tanzania, 67,000 in Uganda 41,000 in Kenya) go out on the lake in small boats every day. Less than half of the fishing boats have a motor. The total lake-side population is estimated at 5.4 million, including an estimated 610,000 people living on lake islands who rely on marine transport.

There are some large vessels operating on the Lake and the East African Community has ambitious plans to invest in the revival of lake transport to improve regional connectivity and trade.

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Socio-economic benefit analysis

Investing in Weather and climate services (W&CS) leads to improved information, such as better forecasts, early warning and seasonal forecasts. In turn, these provide economic benefits to users, as they lead to positive outcomes from the actions and decisions that users subsequently take (WMO, 2015). This is known as the value of information.

Analysis of previous early warning systems (EWS) have found these have high socio-economic benefits (Clements et al., 2013: Shreve and Kelman, 2014). These will rise under climate change if hazards increase. The Global Commission on Adaption reported that EWS bring multiple benefits to people and the economy (GCA, 2019).

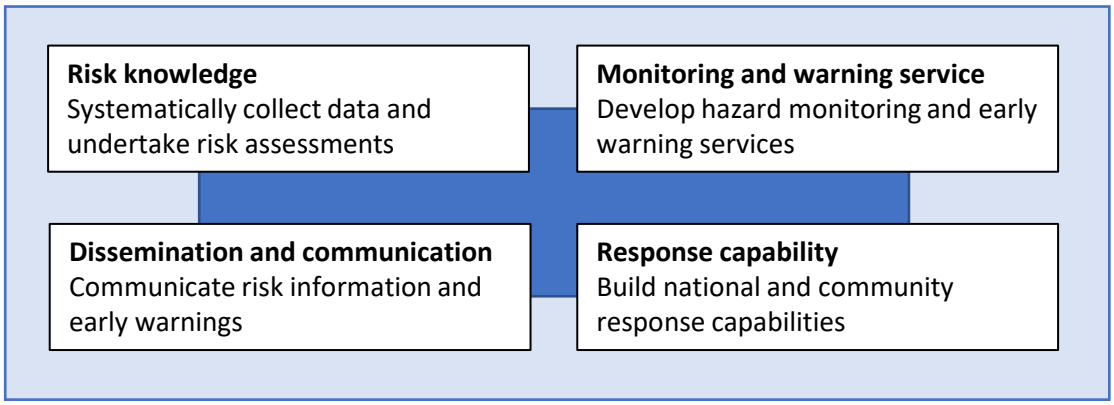
However, to fully realise these benefits, there is a need to invest along the EWS chain, including in science, forecasting capacity, communication and uptake (see box below).

The WISER project has produced guidance on the analysis of socio-economic benefits (WISER, 2017). This has been used in HIGHWAY to estimate the project impact (and the impact indicator on 'value of avoided losses due to use of climate information').

This information has also been used to provide inputs to the project 'business plan', to help ensure the sustainability of regional EWS after the current phase of the HIGHWAY project has finished.

The value chain for weather and climate services

It is important when investing in weather and climate services – and assessing socio-economic benefits – to take account of the entire value chain from the generation of information through to its use. For early warning, this includes four elements for effective EWS, as identified by ISDR below.



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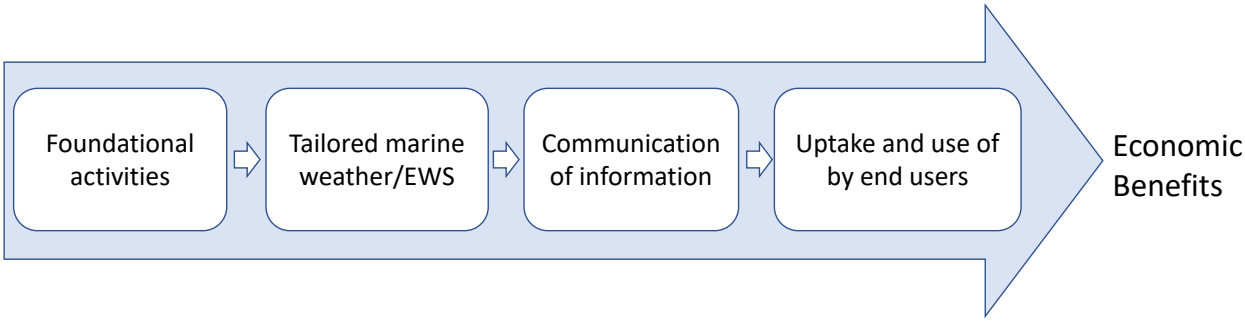
It is the investment along the whole value chain that delivers the economic benefits, and the SEB study has assessed the improvement at each step from HIGHWAY activities.



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Method

The method used was based on the steps in the WISER SEB guidance (WISER, 2017), which are to:

1. Identify the potential socio-economic benefits of the weather and climate service;

2. Review and decide on the SEB approach;

3. Derive the baseline;

4. Assess the change with the new weather and climate service in place, i.e. the socio-economic benefits, taking into account the whole value chain, where possible in monetary terms;

5. Assess the costs of the project, and compare benefits against these costs;

6. Identify omissions, consider bias and undertake sensitivity analysis;

7. Explore how benefits could be enhanced through interventions along the weather chain, including recommendations to enhance benefits.

The benefits and approach

The SEB study identified the potential benefits arising from the Lake Victoria marine weather forecasts and associated severe weather warnings. These included benefits for fisherfolk, small transport boat operators and their passengers, large boats, fish processors, fish traders, and the tourism and recreational sectors.

Tangible benefits include reduced damage to boats and their equipment, savings in the consumption of outboard motor fuel and reduced post-harvest losses for fish drying and transport. Intangible (non-market) benefits include reduced fatalities. Alongside these, the SEB study identified a series of indirect benefits, to the dependants of fisherfolk, and wider economic benefits for other potential users of weather information around the Lake.

There are a range of methods to assess these SEBs. The most obvious way to assess project benefits for HIGHWAY would be to collate statistics on the drownings on the Lake, before and after the project. However, there are currently no accurate statistics.

Study Focus Group Meeting

The HIGHWAY study therefore used a combination of desk analysis, field research, interviews, focus group discussions and surveys conducted by telephone and WhatsApp to assess the project's benefits using a value chain analysis. Fifteen focus groups were held across Uganda and Kenya at 15 different land sites to gather information on the communication, perceived accuracy and uptake of the HIGHWAY regular weather forecasts and severe weather warnings. Further interviews were held to investigate the data available on drowning statistics with relevant authorities.

The economic benefits were then estimated, and valued using information from the field research (e.g. on boat fuel use and costs) and the economic literature.

Baseline

Baseline information was collected by Powell (2018) and WMO (2019). These estimated that the number of users reached with relevant Lake weather information was below 5%. The baseline analysis also found that national forecasts of all three countries contained very little information of relevance to small boat users in Lake Victoria and very few people in fishing communities paid attention to them. New work to assess baseline fatalities was also undertaken.

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Analysis of HIGHWAY project benefits

The study analysis was used to understand the benefits of the HIGHWAY activities at each stage in the value chain analysis.

Foundational activities and forecast accuracy. The foundational activities, including the advances in the science, the investment in meteorological equipment (including the field campaign), and meteorological staff training and capacity building, have led to an improved set of Lake Victoria weather forecasts, which provide much more targeted and accurate information. It is difficult to estimate the individual contribution of each element, but focus group discussions and interviews with users found a high level of forecast accuracy – about 70%.

Communication of information. The introduction of new marine weather forecast bulletins, co-designed by the national met agencies for small craft users on Lake Victoria, and major improvements in the way weather information was communicated to lakeside and island communities, dramatically improved the reach and impact of the weather information generated and disseminated under HIGHWAY.

The forecasts were targeted at local radio stations serving lakeside and island communities, with training on how to translate the forecasts accurately into local languages, and guidance on the times to broadcast forecast bulletins. HIGHWAY also piloted the use of WhatsApp to disseminate forecasts to key users, including radio journalists, officials, fishermen's leaders and community intermediaries at landing sites. The findings from focus groups found around 85% of potential users at landing sites were accessing the improved weather information.

User uptake of information. The activities undertaken to increase use of weather information, including sensitisation at selected landing sites, including use of community intermediaries, weather flags and weather noticeboards (secondary local communication) led to greater use of the information. The focus groups at these landing sites indicated that, 75% of those who receive weather information use it to inform their decision making.

Actions taken. The interviews and focus groups revealed a large number of actions are being taken by end-users in response to the weather forecasts and severe weather warnings:

- Fishermen and small passenger boat operators take life jackets, wet weather gear and extra fuel.
- If severe weather is forecast, they often postpone or cancel their trips or avoid going out too far in the lake. Passenger/cargo boat operators carry a lighter load.
- Rescue services are alerted and put on standby to respond to any emergencies.
- Boat owners and skippers secure vessels moored at the landing site to prevent damage from high wind or large waves.
- Skippers use wind and wave information from the forecast to adjust their routing in order to reduce fuel consumption and save money.
- Silver fish dryers and traders cover fish to protect them from rain, and alter their fish purchasing strategy if rain is forecast.
- Travellers use the forecasts to avoid undertaking journeys in small boats at times when travel is likely to be uncomfortable or dangerous.
- Other stakeholders also use the marine forecasts to inform their decisions. They include farmers, tourism operators and a company that provides electricity and water supply services.

Case studies are reported over the page.

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HIGHWAY Case studies

Reduced fatalities. In Uganda, key informant interviews and focus group discussions with fishing communities in the Ssese Islands, an archipelago of 63 inhabited islands with a population of about 70,000, found the marine forecast had helped to bring about a sharp fall in the number of people who had drowned in the year to May 2020. They reported a 40% reduction compared to the previous 12-month period. A telephone and WhatsApp survey of fishermen leaders in all 13 lakeside districts of Uganda produced similar findings. Interviews with BMU county chairmen in Kenya indicated a reduction of about 30% in the number of fatalities reported to them over the same period, although the level of reduction reported varied considerably from one county to another.

The benefits for fish drying activities. In all three countries that share Lake Victoria, women buy silver fish from fishermen and dry in the sun for two or three days to preserve it. The fish are dried on mats spread out at the landing site or on raised racks of netting. Once the fish is dried it is bagged up and sold wholesale. If it rains while the fish is drying, the fish starts to rot, and the women have to sell at a steep discount (up to 50%). This represents a large direct weather impact on the earnings of fish processors.

Silver Fish processors in Uganda reported that before the UNMA forecast came along they suffered significant losses from rotting fish during the rainy seasons. Interviews found that many fish dryers are using the UNMA marine weather forecast to inform their fish buying activities. If there is a strong likelihood of rain, they buy less fresh fish. They estimated the forecasts allow them to save up to $100/month. Some of the women fish dryers also own boats. Interviews found they use the afternoon forecast to plan fishing boat activities for the coming night. If the winds are forecast to be strong or the waves high, they provide extra fuel for the outboard motor. If the weather forecast is very bad, they do not allow the boats to go out at all.

Fuel savings. Fishermen, transporters and fishing boat owners reported substantial savings in outboard motor fuel from choosing routes that avoided sailing against the wind or through large waves. These savings ranged from 15 to 30 litres of fuel per boat per week. Based on current fuel costs, this indicates potentially savings for $750 and $1,500 per year. Interviews on the Ssese archipelago with local fish traders found that many of them use the marine forecast to guide their activities. If severe weather is forecast, they carry extra fuel and more ice when transporting fresh fish from island landing sites to markets on the mainland

Enhancing uptake through WhatsApp. KMD and UNMA have started to use WhatsApp groups to disseminate their marine forecasts for Lake Victoria. The WhatsApp groups also act as a channel for issuing ad hoc weather alerts in between the publication of regular forecast bulletins and other weather forecast information. The daily feedback received from forecast users through the WhatsApp groups has also provided an important stimulus to the KMD and UNMA forecasters. The forecasters themselves say that getting to know their target audience and appreciating their need for accurate weather information has motivated them to be more careful in the preparation of each bulletin. This has led to an improvement in the level of accuracy of both Kenya and Uganda since they were launched.

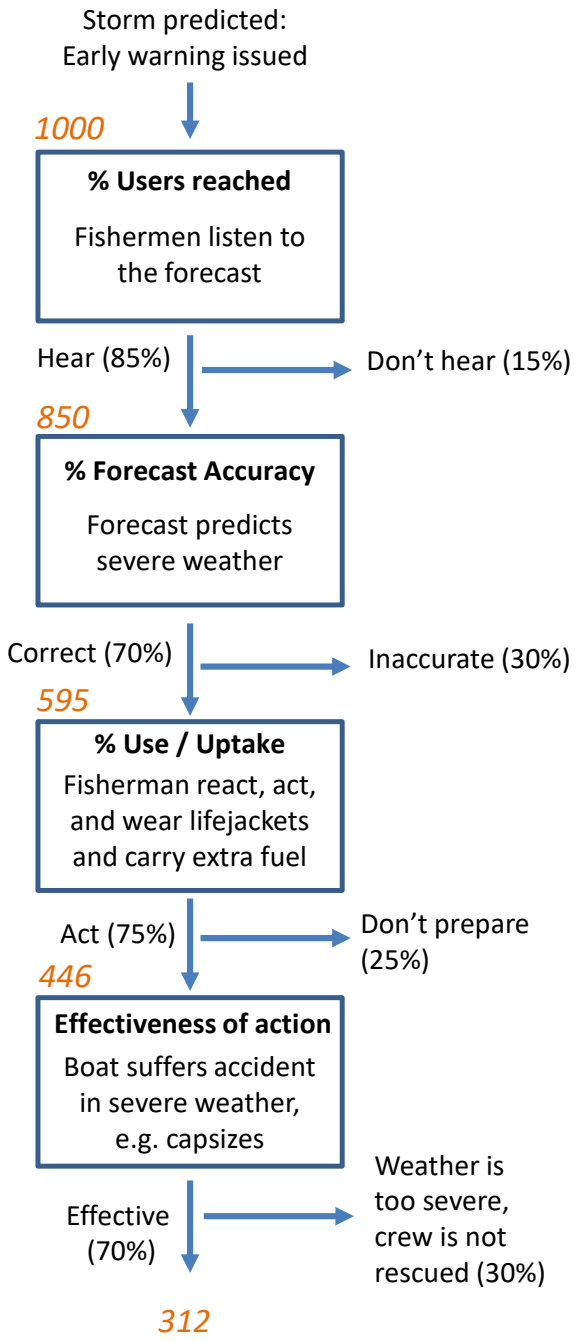
Overall, the weather information is leading to safer navigation on the lake. It is also producing financial benefits from fuel savings, and avoided losses (damage to boats, lost nets, and lost boats). The bulletins are credited with bringing about behaviour changes that have improved marine security and saved many lives among fishermen, small transport boat operators and their passengers.

The level of benefits realised from the actions above will depend on the end action taken in response to the weather information received, but the effectiveness will not be 100%. For example, the action taken may still not be sufficient to prevent a fatality. Based on field analysis, the study has used an indicative figure of 70% effectiveness.

Looking at the overall value chain, the improvement (in % accuracy, reach, communication and use) at each stage is impressive. Nevertheless, there is still a significant loss of efficiency across the weather chain. This is shown in the flow chart opposite.

This takes the figures derived from the surveys (in the paragraphs above), and applies them to an example of a severe weather forecast for a storm. At each successive stage there is a fall-off in the efficiency, e.g. due to the % of people who hear the forecast, or the ability to accurately forecast a storm, as well as the trust that users have in the forecast and thus their willingness to take action. Overall, the level of benefits, as compared to perfect information and use, are estimated at just over 30%.

This information has been used to estimate benefits. However, it also provides key information on how the service can be enhanced in the future, by targeting the most important efficiency losses.



Example of weather service chain analysis, showing the efficiency losses through to final end user action and therefore overall benefit

The results of the study indicate that the HIGHWAY project is leading to approximately a 30% reduction in weather related deaths on Lake Victoria. Assuming the current baseline is 1,000 deaths per year– this would be a reduction of over 300 deaths per year

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The study then estimated the economic value of the reduced impacts. The impacts on health are more difficult to value than other sectors, because there are no observed market prices. However, it is possible to derive values by considering the total effect on society's welfare. For the valuation of fatalities, the focus is on valuing the change in the risk of mortality (not the valuation of life itself). While these values are often seen as controversial, they are widely used in economic appraisal.

For this study, we used the value of statistical life, (also known as the value of a prevented fatality), transferred to the country context. This was used for a central estimate. We also compared this to a simple rule of thumb approach with a GDP per capita multiplier to provide an upper estimate. The impact on dependants was captured by applying an uplift to these values.

The additional benefits of other reduced losses or benefits was also estimated. This included the analysis of the potential benefits from reduced loss of boats and equipment.

There was widespread agreement in focus groups that the forecasts are reducing fuel consumption of outboard motors. An analysis of these benefits, taking account of value chain efficiency, indicates the fuel savings could be $10 to $20 million year to HIGHWAY.

A further group of user benefits were found to arise for fish driers (see also the case study page). Focus group discussion were held to understand and quantify these benefits. Indicative analysis indicates the reduced losses to fish driers could be $1 to $3 million year due to improved weather information. These benefits accrue almost entirely to women.

The SEB study also undertook new analysis to try and assess the numbers of fatalities each year on the lake, and the reduction in deaths from the use of HIGHWAY weather information. Based on data gathered in Kenya and Uganda, the SEB study estimates that the number of people who die on the lake is currently lower than 3000/year, perhaps half this number. This appears to be due to the more routine use of life jackets, the trend towards using larger boats powered by outboard motors (rather than sail), and administrative interventions to stop boats going out in bad weather. Furthermore, not all of these deaths are due to weather events. An indicative baseline of 1000 weather related fatalities/year was therefore used.

Interviews with officials supported the view that most of the reduction in fatalities since 2019 were attributed to stronger precautions taken by fishermen, transport boat operators and their passengers on the basis of the HIGHWAY forecasts. The indicative statistics indicate drownings have fallen by around one third to one

half with the forecasts in place, and correlate with the efficiency analysis.

Adding these benefits together, the study estimates that the economic benefits of HIGHWAY activities are $44 million/year (central estimate).

When these benefits are compared to the project costs, HIGHWAY has an extremely large benefit-cost ratio. There are also additional indirect benefits that arise from the HIGHWAY assisted marine forecasts. These include benefits for the larger lake vessels (ferries and cargo ships), and the agriculture and tourism sectors, although these have not been quantified. There are also wider benefits arising from the weather forecast-related decisions taken by the 5.4 million people who live in lakeside communities around the coastline of Lake Victoria and on islands in the lake, and from the improved severe weather forecasting capacity and training from Rwanda's involvement in the HIGHWAY project.

Enhancing benefits (next phase)

Building on HIGHWAY, the National Meteorological and Hydrological Services (NMHSs) of the East African Community (EAC) have agreed to develop a more integrated and collaborative regional approach to the delivery of Early Warning Services (EWS) over the period 2020–2025. This EWS Vision 2025 enhances the existing marine weather information and expands the sectoral coverage (to other sectors impacted by severe weather).

For the marine information, the activities will reduce the efficiency losses, and increase the benefits of the current scheme. Based on the activities planned, and the field research and focus groups, the SEB study estimates there would be improvements in the communication of marine weather (the reach), improved accuracy of the forecasts and the severe weather warnings, from advancement of science, and planned NMS investments in infrastructure and staffing capacity.

Moving to use and uptake, the EWS Vision 2025 would draw on the HIGHWAY activities, which used community outreach initiatives (and intermediaries) at landing sites, to raise awareness among potential users and communicate weather information. The HIGHWAY pilot activities in the Ssese Islands in Uganda and along the western shore of Homa Bay County in Kenya showed that such outreach activities led to significantly higher uptake of information, and effective use.

With these updates, the efficiency losses in the weather chain would fall dramatically, reducing the total weather-related deaths by 66% (compared to the pre-HIGHWAY baseline). EWS Vision 2025 would increase the benefits of marine information significantly, with estimated benefits of $83.5million/year on Lake Victoria, almost double that of HIGHWAY.

There would also be additional benefits to other users from improved Lake information. Furthermore, the new services developed in EWS 2025 for shore-based users would provide severe weather warning for lakeside floods and storms, as well as improved weather forecasts that could benefit millions of beneficiaries, generating large-scale socio-economic benefits.

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