Science for Humanitarian Emergencies and Resilience

Key Learning and Resources

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Science for Humanitarian Emergencies & Resilience
SHEAR

In partnership with:

Science for Humanitarian Emergencies and Resilience: Key Learning and Resources

Science for Humanitarian Emergencies and Resilience (SHEAR) was an interdisciplinary, international research programme jointly funded by the UK's Foreign, Commonwealth & Development Office (FCDO) and the Natural Environmental Research Council (NERC).

It aimed to support improved disaster resilience and humanitarian response by advancing monitoring, assessment and prediction of natural hazards and risks across sub-Saharan Africa and South Asia.

SHEAR worked with stakeholders to co-produce demand-led, people-centred science and solutions to improve risk assessment, preparedness, early action and resilience to natural hazards.

This directory provides and overview and links to a range of resources developed throughout the programme to synthesise emerging findings, learning, and experience from SHEAR across different areas relating to early warning and early action, and to the implementation of interdisciplinary research.

Contents

SHEAR: Key Programme Resources

SHEAR Around the World

The SHEAR programme carried out innovative research, in some of the most hazard-prone parts of the world, to better understand and forecast disasters, and minimize the risk they pose to vulnerable communities. This document outlines the work being carried out by SHEAR projects in different countries.

SHEAR Impact

Research from SHEAR has had a positive impact around the world. You can explore some of these inspiring stories in this document which highlights the tremendous value of the collaborative research-practice work conducted under the programme.

SHEAR in 2020

Between the coronavirus pandemic and a particularly severe natural hazard calendar, the importance of translating science into practice in order to anticipate, prepare for, and respond to disasters, was made ever more clear. This short document summarises a few of these stories of applications of science to the humanitarian sector as SHEAR researchers around the world developed tools, publications, and relationships to enable practitioners and communities toward resilience.

Understanding hazard risk

Earthquakes and Landslides in Nepal

The earthquake which hit Nepal on 25th April 2015 was the worst the country had experienced in 90 years. This brief outlines the research SHEAR projects have been conducting to improve the understanding of aftershock and landslide risks, so that disaster risk reduction planning can be improved, and resilience strengthened.

Applied Earth observations for the disaster management sector

Earth observations can support crucial humanitarian activities such as disaster management and disaster risk assessment. This knowledge product explores examples of how Earth observations have been used within the disaster management and disaster risk reduction contexts alongside a discussion of the current uses, ethics, and the future of Earth observation data.

Improved data to better understand exposure, vulnerabilities, and hazards

Data plays a key role in preparing for, and responding to, disaster risks. With improved quality, availability and accessibility of hazard-related data, disaster impacts can be better defined and anticipated. This brief explores key improvements in data delivered by SHEAR projects.

Understanding hazard risk: Peer reviewed papers

Understanding landslide risk

Alvioli, M., Mondini, A. C., Fiorucci, F., Cardinali, M., & Marchesini, I. (2018). Topography-driven satellite imagery analysis for landslide mapping. *Geomatics, Natural Hazards and Risk*, *9*(1), 544-567.

Cieslik, K., Shakya, P., Uprety, M., Dewulf, A., Russell, C., Clark, J., ... & Dhakal, A. (2019). Building resilience to chronic landslide hazard through citizen science. *Frontiers in Earth Science*, 278.

Dini, B., Bennett, G. L., Franco, A., Whitworth, M. R., Cook, K. L., Senn, A., & Reynolds, J. M. (2021). Development of smart boulders to monitor mass movements via the Internet of Things: a pilot study in Nepal. *Earth Surface Dynamics*, *9*(2), 295-315.

Gariano, S. L., Melillo, M., Peruccacci, S., & Brunetti, M. T. (2020). How much does the rainfall temporal resolution affect rainfall thresholds for landslide triggering?. *Natural Hazards*, *100*(2), 655-670.

Kincey, M. E., Rosser, N. J., Robinson, T. R., Densmore, A. L., Shrestha, R., Pujara, D. S., ... & Swirad, Z. M. (2021).Evolution of coseismic and post-seismic landsliding after the 2015 Mw 7.8 Gorkha earthquake, Nepal. *Journal of Geophysical Research: Earth Surface*, *126*(3), e2020JF005803.

Muñoz-Torrero Manchado, A., Allen, S., Ballesteros-Canovas, J. A., Dhakal, A., Dhital, M. R., & Stoffel, M. (2021). Three decades of landslide activity in western Nepal: new insights into trends and climate drivers. *Landslides*, *18*(6), 2001-2015.

Neal, R., Robbins, J., Dankers, R., Mitra, A., Jayakumar, A., Rajagopal, E. N., & Adamson, G. (2020). Deriving optimal weather pattern definitions for the representation of precipitation variability over India. *International Journal of Climatology*, *40*(1), 342-360.

Rosser, N., Kincey, M., Oven, K., Densmore, A., Robinson, T., Pujara, D. S., ... & Dhital, M. R. (2021). Changing significance of landslide hazard and risk after the 2015 Mw 7.8 Gorkha, Nepal earthquake. Progress *in Disaster Science*, *10*, 100159.

Understanding drought risk

Bowell, A., Salakpi, E. E., Guigma, K., Muthoka, J. M., Mwangi, J., & Rowhani, P. (2021).Validating commonly used drought indicators in Kenya. *Environmental Research Letters*, *16*(8), 084066.

Israelsson, J., Black, E., Neves, C., Torgbor, F. F., Greatrex, H., Tanu, M., & Lamptey, P. N. L. (2020). The spatial correlation structure of rainfall at the local scale over southern Ghana. *Journal of Hydrology: Regional Studies*, *31*, 100720.

Franchi, F., Ahad, J. M., Geris, J., Jhowa, G., Petros, A. K., & Comte, J. C. (2020). Modern sediment records of hydroclimatic extremes and associated potential contaminant mobilization in semi-arid environments: lessons learnt from recent flood-drought cycles in southern Botswana. *Journal of Soils and Sediments*, *20*(3), 1632-1650.

Understanding flood risk

Chen, H., Liang, Q., Liang, Z., Liu, Y., & Ren, T. (2020). Extraction of connected river networks from multi-temporal remote sensing imagery using a path tracking technique. *Remote Sensing of Environment*, *246*, 111868.

Ficchì, A., & Stephens, L. (2019). Climate variability alters flood timing across Africa. *Geophysical Research Letters*, *46*(15), 8809-8819.

Ficchì, A., Cloke, H., Neves, C., Woolnough, S., de Perez, E. C., Zsoter, E., ... & Stephens, E. (2021). Beyond El Niño: unsung climate modes drive African floods. *Weather and Climate Extremes*, *33*, 100345.

Hossain, S., Cloke, H. L., Ficchì, A., Turner, A. G., & Stephens, E. (2019). Hydrometeorological drivers of the 2017 flood in the Brahmaputra basin in Bangladesh. *Hydrology and Earth System Sciences Discussions*, 1-33.

Jiang, L., Hu, Y., Xia, X., Liang, Q., Soltoggio, A., & Kabir, S. R. (2020). A multi-scale mapping approach based on a deep learning CNN model for reconstructing high-resolution urban DEMs. *Water*, *12*(5), 1369.

MacLeod, D. A., Dankers, R., Graham, R., Guigma, K., Jenkins, L., Todd, M. C., ... & Mwangi, E. (2021). Drivers and subseasonal predictability of heavy rainfall in equatorial East Africa and relationship with flood risk. *Journal of Hydrometeorology*, *22*(4), 887-903.

Mustafa, S. M., Loon, A. V., Artur, L., Bharucha, Z., Chinyama, A., Chirindja, F., ... & Comte, J. C. (2021). Multisector Collaborative Groundwater-Surface Water Modelling Approach to Improve Resilience to Hydrological Extremes in the Limpopo River Basin. In *Advances in Geoethics and Groundwater Management: Theory and Practice for a Sustainable Development* (pp. 397-400). Springer, Cham.

Peppa, M. V., Maharjan, S. B., Joshi, S. P., Xiao, W., & Mills, J. P. (2020). Glacial lake evolution based on remote sensing time series: A case study of Tsho Rolpa in Nepal. *ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences*.

Titley, H. A., Cloke, H. L., Harrigan, S., Pappenberger, F., Prudhomme, C., Robbins, J. C., & Zsótér, E. (2021). Key factors influencing the severity of fluvial flood hazard from tropical cyclones. *Journal of Hydrometeorology*, *22*(7), 1801-1817.

Understanding heatwaves

Guigma, K. H., Guichard, F., Todd, M., Peyrille, P., & Wang, Y. (2021). Atmospheric tropical modes are important drivers of Sahelian springtime heatwaves. *Climate Dynamics*, *56*(5), 1967-1987.

Guigma, K. H., MacLeod, D., Todd, M., & Wang, Y. (2021). Prediction skill of Sahelian heatwaves out to subseasonal lead times and importance of atmospheric tropical modes of variability. *Climate Dynamics*, *57*(1), 537-556.

Guigma, K. H., Todd, M., & Wang, Y. (2020). Characteristics and thermodynamics of Sahelian heatwaves analysed using various thermal indices. *Climate Dynamics*, *55*(11), 3151-3175.

Lu, S. L., Emmanuel, R., Perera, N., Ratnayake, R., Grimmond, S., Luo, Z., ... & Sun, T. (2020). Reduction of overheating in Sri Lanka: An action research imperative?. *ARCOM*, *36*, 243-252.

Understanding storm risk

Klein, C., & Taylor, C. M. (2020). Dry soils can intensify mesoscale convective systems. *Proceedings of the National Academy of Sciences*, *117*(35), 21132-21137.

Kolusu, S. R., Shamsudduha, M., Todd, M. C., Taylor, R. G., Seddon, D., Kashaigili, J. J., ... & MacLeod, D. A. (2019). The El Niño event of 2015–2016: climate anomalies and their impact on groundwater resources in East and Southern Africa. *Hydrology and Earth System Sciences*, *23*(3), 1751-1762.

MacLeod, D., & Caminade, C. (2019). The moderate impact of the 2015 El Niño over East Africa and its representation in seasonal reforecasts. *Journal of Climate*, *32*(22), 7989-8001.

MacLeod, D., Graham, R., O'Reilly, C., Otieno, G., & Todd, M. (2021). Causal pathways linking different flavours of ENSO with the Greater Horn of Africa short rains. *Atmospheric Science Letters*, *22*(2), e1015.

Ng, K. S., & Leckebusch, G. C. (2020). A New View on Risk of Typhoon Occurrence in the Western North Pacific. *Natural Hazards and Earth System Sciences Discussions*, *2020*, 1-33.

Understanding hazard interactions

Dewulf, A., Karpouzoglou, T., Warner, J., Wesselink, A., Mao, F., Vos, J., & Buytaert, W. (2019). The power to define resilience in social–hydrological systems: Toward a power-sensitive resilience framework. *Wiley Interdisciplinary Reviews: Water*, *6*(6), e1377.

Docherty, J. M., Mao, F., Buytaert, W., Clark, J. R., & Hannah, D. M. (2020). A framework for understanding water-related multi-hazards in a sustainable development context. *Progress in Physical Geography: Earth and Environment*, *44*(2), 267-284.

Franchi, F., Ahad, J. M., Geris, J., Jhowa, G., Petros, A. K., & Comte, J. C. (2020). Modern sediment records of hydroclimatic extremes and associated potential contaminant mobilization in semi-arid environments: lessons learnt from recent flood-drought cycles in southern Botswana. *Journal of Soils and Sediments*, *20*(3), 1632-1650.

Wainwright, C. M., Finney, D. L., Kilavi, M., Black, E., & Marsham, J. H. (2021). Extreme rainfall in East Africa, October 2019–January 2020 and context under future climate change. *Weather*, *76*(1), 26-31.

Understanding experiences and perspectives of hazards

de Wit, S., & Haines, S. (2022). Climate change reception studies in anthropology. *Wiley Interdisciplinary Reviews: Climate Change*, *13*(1), e742.

Whitfield, S., Beauchamp, E., Boyd, D. S., Burslem, D., Byg, A., Colledge, F., ... & White, P. C. (2019). Exploring temporality in socio-ecological resilience through experiences of the 2015–16 El Niño across the Tropics. *Global environmental change*, *55*, 1-14.

Developing early warning

Closing the gap between policy and practice: the role of institutional mapping

Institutional mapping is a vital process to bridge the gap between policy and practice. This brief outlines lessons learned about the importance of stakeholder mapping and effective practice drawn from the development of a prototype landslide early warning system in India.

Use of Social Media for EWS

The recent growth in technology and use of social media provides an opportunity for additional streams of information for decision making, and channels for disseminating early warning and risk information. This document outlines some of the ways social media can be used in natural hazard early warning systems, providing examples of where it is already being used.

Using Mobile Phone Technologies for Disaster Risk Management: Reflections from SHEAR

In October 2020, SHEAR hosted a virtual workshop which explored the use of mobile technologies to support disaster risk management. The workshop brought together approximately 45 members from 20 organisations across the SHEAR Programme and a selection of external experts to share and record their experiences.

The breadth and depth of expertise and experience from workshop participants provided an opportunity to gather key learnings and examine common challenges and opportunities where mobile technologies could be usefully harnessed through different stages of the DRM lifecycle, and across different regions. This publication summarises the key learnings from the workshop: how mobile phone technologies are used in DRM, and the opportunities and lessons for applied research.

Introduction to Landslide Early Warning Systems

The Science for Humanitarian Emergencies and Resilience (SHEAR) programme supports world-leading research to enhance the quality, availability and use of risk and forecast information. This paper aims to synthesise learning and knowledge from across SHEAR to produce a short introduction to landslide early warning systems for practitioners, donors, and researchers in developing countries.

Introduction to Local Landslide Early Warning Systems

This introductory guide includes an overview of monitoring and warning methods, the role of community engagement, and challenges to local landslide early warning systems.

Introduction to Regional Landslide Early Warning Systems

This introductory guide includes an overview of data used, institutional roles, and dissemination and communication approaches for regional landslide early warning systems.

Developing early warning: Peer reviewed papers

Early warning for floods

Budimir, M., Donovan, A., Brown, S., Shakya, P., Gautam, D., Uprety, M., ... & Dugar, S. (2020). Communicating complex forecasts: an analysis of the approach in Nepal's flood early warning system. *Geoscience Communication*, *3*(1), 49-70.

Kilavi, M., MacLeod, D., Ambani, M., Robbins, J., Dankers, R., Graham, R., ... & Todd, M. C. (2018). Extreme rainfall and flooding over central Kenya including Nairobi city during the long-rains season 2018: causes, predictability, and potential for early warning and actions. *Atmosphere*, *9*(12), 472.

Pandeya, B., Uprety, M., Paul, J. D., Sharma, R. R., Dugar, S., & Buytaert, W. (2021). Mitigating flood risk using low-cost sensors and citizen science: A proof-of-concept study from western Nepal. *Journal of Flood Risk Management*, *14*(1), e12675.

Early warning for landslides

Guzzetti, F., Gariano, S. L., Peruccacci, S., Brunetti, M. T., Marchesini, I., Rossi, M., & Melillo, M. (2020). Geographical landslide early warning systems. *Earth-Science Reviews*, *200*, 102973.

Mondini, A. C., Santangelo, M., Rocchetti, M., Rossetto, E., Manconi, A., & Monserrat, O. (2019). Sentinel-1 SAR amplitude imagery for rapid landslide detection. *Remote sensing*, *11*(7), 760.

Williams, J. G., Rosser, N. J., Kincey, M. E., Benjamin, J., Oven, K. J., Densmore, A. L., ... & Dijkstra, T. A. (2018). Satellite-based emergency mapping using optical imagery: experience and reflections from the 2015 Nepal earthquakes. *Natural hazards and earth system sciences*, *18*(1), 185-205.

Phengsuwan, J., Shah, T., James, P., Thakker, D., Barr, S., & Ranjan, R. (2020). Ontology-based discovery of time-series data sources for landslide early warning system. *Computing*, *102*(3), 745-763.

Phengsuwan, J., Shah, T., Sun, R., James, P., Thakker, D., & Ranjan, R. (2020). An ontology-based system for discovering landslide-induced emergencies in electrical grid. *Transactions on Emerging Telecommunications Technologies*, e3899.

Early warning communications and management

Budimir, M., Sneddon, A., Nelder, I., Brown, S., Donovan, A., & Speight, L. (2021). Development of forecast information for institutional decision-makers: landslides in India and cyclones in Mozambique. *Geoscience Communication Discussions*, 1-34.

Calvel, A., Werner, M., Van den Homberg, M., Cabrera Flamini, A., Streefkerk, I., Mittal, N., ... & Boyce,C. (2020). Communication structures and decision making cues and criteria to support effective drought warning in Central Malawi. *Frontiers in Climate*, 16.

Liu, W. (2019). Operationalizing Polycentricity for Landscape Resilience. *Landscape Architecture Frontiers*, *7*(3), 9-12.

Mao, F., Clark, J., Buytaert, W., Krause, S., & Hannah, D. M. (2018). Water sensor network applications: Time to move beyond the technical?. *Hydrological Processes*, *32*(16), 2612-2615.

Mao, F., Khamis, K., Clark, J., Krause, S., Buytaert, W., Ochoa-Tocachi, B. F., & Hannah, D. M. (2020). Moving beyond the technology: a socio-technical roadmap for low-cost water sensor network applications. *Environmental Science & Technology*, *54*(15), 9145-9158.

Mao, F., Khamis, K., Krause, S., Clark, J., & Hannah, D. M. (2019). Low-cost environmental sensor networks: recent advances and future directions. *Frontiers in Earth Science*, 221.

Paul, J. D., Bee, E., & Budimir, M. (2021). Mobile phone technologies for disaster risk reduction. *Climate Risk Management*, *32*, 100296.

Assessing and exploring approaches to early warning

Paul, J. D., Buytaert, W., & Sah, N. (2020). A technical evaluation of lidar-based measurement of river water levels. *Water Resources Research*, *56*(4), e2019WR026810.

Paul, J. D., Buytaert, W., Allen, S., Ballesteros-Cánovas, J. A., Bhusal, J., Cieslik, K., ... & Supper, R. (2018). Citizen science for hydrological risk reduction and resilience building. *Wiley Interdisciplinary Reviews: Water*, *5*(1), e1262.

Paul, J. D., Cieslik, K., Sah, N., Shakya, P., Parajuli, B. P., Paudel, S., ... & Buytaert, W. (2020). Applying Citizen Science for Sustainable Development: Rainfall Monitoring in Western Nepal. *Frontiers in Water*, *2*, 62.

Paul, J. D., Hannah, D. M., & Liu, W. (2020). Editorial: Citizen Science: Reducing risk and building resilience to natural hazards. Front. *Citizen Science: Reducing Risk and Building Resilience to Natural Hazards*, *7*, 320.

Developing early action

SHEAR in Crises

Forecasting extreme weather events is one of the main aims of SHEAR. The programme's extensive research has already been put into practice during recent humanitarian emergencies, notably through forecast-based action programmes in the Red Cross Red Crescent. The stories of SHEAR research being used provide a strong evidence base for the value of such work and collaborations, and are outlined in this brief.

Linking Social Protection and Forecast-Based Action

There has been a growing interest in exploring the scope for linking forecast-based action (FbA) and social protection (SP). In this forward looking brief, we have explored the potential questions and areas of exploration that require further research in order to understand the feasibility of integrating FbA and SP.

Developing early action: Peer reviewed papers

Supporting preparedness and anticipatory action

Coughlan de Perez, E., Stephens, E., Bischiniotis, K., Van Aalst, M., Van Den Hurk, B., Mason, S., ... & Pappenberger, F. (2017). Should seasonal rainfall forecasts be used for flood preparedness?. *Hydrology and Earth System Sciences*, *21*(9), 4517-4524.

de Perez, E. C., Stephens, E., van Aalst, M., Bazo, J., Fournier-Tombs, E., Funk, S., ... & Lowe, R. (2021). Epidemiological versus meteorological forecasts: Best practice for linking models to policymaking. *International Journal of Forecasting*.

Emerton, R., Cloke, H., Ficchi, A., Hawker, L., de Wit, S., Speight, L., ... & Stephens, E. (2020). Emergency flood bulletins for Cyclones Idai and Kenneth: A critical evaluation of the use of global flood forecasts for international humanitarian preparedness and response. *International Journal of Disaster Risk Reduction*, *50*, 101811.

Boult, V. L., Asfaw, D. T., Young, M., Maidment, R., Mwangi, E., Ambani, M., ... & Black, E. (2020). Evaluation and validation of TAMSAT-ALERT soil moisture and WRSI for use in drought anticipatory action. *Meteorological Applications*, *27*(5), e1959.

MacLeod, D., Kilavi, M., Mwangi, E., Ambani, M., Osunga, M., Robbins, J., ... & Todd, M. C. (2021). Are Kenya Meteorological Department heavy rainfall advisories useful for forecast-based early action and early preparedness for flooding?. *Natural Hazards and Earth System Sciences*, *21*(1), 261-277.

MacLeod, D., Kniveton, D. R., & Todd, M. C. (2021). Playing the long game: Anticipatory action based on seasonal forecasts. *Climate Risk Management*, *34*, 100375.

Mwangi, E., Taylor, O., Todd, M. C., Visman, E., Kniveton, D., Kilavi, M., ... & Colman, A. (2021). Mainstreaming forecast based action into national disaster risk management systems: experience from drought risk management in Kenya. *Climate and Development*, 1-16.

Phengsuwan, J., Shah, T., Thekkummal, N. B., Wen, Z., Sun, R., Pullarkatt, D., ... & Ranjan, R. (2021). Use of social media data in disaster management: a survey. *Future Internet*, *13*(2), 46.

Phengsuwan, J., Thekkummal, N. B., Shah, T., James, P., Thakker, D., Sun, R., ... & Ranjan, R. (2019, July). Context-based Knowledge Discovery and Querying for Social Media Data. In *2019 IEEE 20th International Conference on Information Reuse and Integration for Data Science (IRI)* (pp. 307-314). IEEE.

Disaster risk financing and insurance

Asfaw, D., Black, E., Brown, M., Nicklin, K. J., Otu-Larbi, F., Pinnington, E., ... & Quaife, T. (2018). TAMSAT-ALERT v1: a new framework for agricultural decision support. *Geoscientific Model Development*, *11*(6), 2353-2371.

Afshar, M. H., Foster, T., Higginbottom, T. P., Parkes, B., Hufkens, K., Mansabdar, S., ... & Kramer, B. (2021). Improving the Performance of Index Insurance Using Crop Models and Phenological Monitoring. *Remote Sensing*, *13*(5), 924.

Hufkens, K., Melaas, E. K., Mann, M. L., Foster, T., Ceballos, F., Robles, M., & Kramer, B. (2019). Monitoring crop phenology using a smartphone based near-surface remote sensing approach. *Agricultural and forest meteorology*, *265*, 327-337.

Suchato, P., Mieno, T., Schoengold, K., & Foster, T. (2019). The potential for moral hazard behavior in irrigation decisions under crop insurance. *Agricultural Economics*.

Parkes, B., Higginbottom, T. P., Hufkens, K., Ceballos, F., Kramer, B., & Foster, T. (2019). Weather dataset choice introduces uncertainty to estimates of crop yield responses to climate variability and change. *Environmental Research Letters*, *14*(12), 124089.

Monitoring, modelling, and forecasting

Improved forecasting helps people prepare for the weather and the seasons

This brief outlines SHEAR's advances made in developing new or improved forecast products for various natural hazards and their impacts in Asia and Africa. SHEAR projects have worked to advance the quality of the forecast information to support preparedness, by increasing the confidence, credibility and usability of forecasting science

The Future of Forecasts: Impact-Based Forecasting for Early Action

This guide outlines the steps and tools needed to develop impact-based forecasting: from understanding risk to producing, issuing and verifying fit for purpose impact-based forecasts and warnings.

Designed with, and for, people working in impact-based forecasting, early warning and early action, the compiled information and recommendations will be useful for everyone from technical staff in national hydrological and meteorological services to disaster risk management, humanitarian and development agencies. The guide includes case studies from countries around the world to highlight the development and use of impact-based forecasting services for users and producers.

Seasonal Forecast Toolkit

This is a series of short, practical guidance documents with advice on how to interpret and use seasonal forecasts. Seasonal forecasts are a popular forecast product with the added attractiveness of long lead times. However, they are not a panacea, and these guidance documents share the circumstances under which they can be useful for decision-making.

This series draws upon lessons from ongoing research on using seasonal forecasts for early action, as well as from the practice of using seasonal forecasts in climate services projects. It is written by people working along different parts of the climate services value chain including - producing seasonal forecasts, interpreting, and disseminating for action – for those who are relatively new to climate services.

Gaining user insights into the research-to-operational elements of Impact-based Forecasting (IbF) from within the SHEAR programme : summary of findings

In the context of weather forecasting, Impact-based forecasting (IbF) reflects a shift from describing and communicating what the hazard will be and where, to what the hazard might do and where. The SHEAR programme has been exploring IbF in a number of interdisciplinary research projects, and this paper brings together learning, experience and perspectives from across these projects and others about what IbF Is, and the challenges, barriers and opportunities associated with implementing IbF operationally.

Monitoring, modelling, and forecasting: Peer reviewed papers

Rainfall

Colman, A. W., Graham, R. J., & Davey, M. K. (2020). Direct and indirect seasonal rainfall forecasts for East Africa using global dynamical models. *International Journal of Climatology*, *40*(2), 1132-1148.

de Andrade, F. M., Young, M. P., MacLeod, D., Hirons, L. C., Woolnough, S. J., & Black, E. (2021). Subseasonal precipitation prediction for Africa: Forecast evaluation and sources of predictability. *Weather and Forecasting*, *36*(1), 265-284.

Drought

Barrett, A. B., Duivenvoorden, S., Salakpi, E. E., Muthoka, J. M., Mwangi, J., Oliver, S., & Rowhani, P. (2020). Forecasting vegetation condition for drought early warning systems in pastoral communities in Kenya. *Remote Sensing of Environment*, *248*, 111886.

Floods

Chen, H., Zhao, J., Liang, Q., Maharjan, S. B., & Joshi, S. P. (2022). Assessing the potential impact of glacial lake outburst floods on individual objects using a high-performance hydrodynamic model and open-source data. *Science of The Total Environment*, *806*, 151289.

Emerton, R., Zsoter, E., Arnal, L., Cloke, H. L., Muraro, D., Prudhomme, C., ... & Pappenberger, F. (2018). Developing a global operational seasonal hydro-meteorological forecasting system: GloFAS-Seasonal v1. 0. *Geoscientific Model Development*, *11*(8), 3327-3346.

Xia, X., Liang, Q., & Ming, X. (2019). A full-scale fluvial flood modelling framework based on a high-performance integrated hydrodynamic modelling system (HiPIMS). *Advances in Water Resources*, *132*, 103392.

Zsótér, E., Cloke, H. L., Prudhomme, C., Harrigan, S., de Rosnay, P., Munoz-Sabater, J., & Stephens, E. (2020). Trends in the GloFAS-ERA5 river discharge reanalysis. *ECMWF Technical Memoranda*, (871).

Zsoter, E., Prudhomme, C., Stephens, E., Pappenberger, F., & Cloke, H. (2020). Using ensemble reforecasts to generate flood thresholds for improved global flood forecasting. *Journal of Flood Risk Management*, *13*(4), e12658.

Landslides

Melillo, M., Brunetti, M. T., Peruccacci, S., Gariano, S. L., Roccati, A., & Guzzetti, F. (2018). A tool for the automatic calculation of rainfall thresholds for landslide occurrence. *Environmental Modelling & Software*, *105*, 230-243.

Mondini, A. C., Guzzetti, F., Chang, K. T., Monserrat, O., Martha, T. R., & Manconi, A. (2021). Landslide failures detection and mapping using Synthetic Aperture Radar: Past, present and future. *Earth-Science Reviews*, *216*, 103574.

Xiong, Y., Mahaffey, S., Liang, Q., Rouainia, M., & Wang, G. (2020). A new 1D coupled hydrodynamic discrete element model for floating debris in violent shallow flows. *Journal of Hydraulic Research*, *58*(5), 778-789.

Seasonal forecasting

MacLeod, D. (2018). Seasonal predictability of onset and cessation of the east African rains. *Weather and climate extremes*, *21*, 27-35.

MacLeod, D. (2019). Seasonal forecasts of the East African long rains: insight from atmospheric relaxation experiments. *Climate Dynamics*, *53*(7), 4505-4520.

White, C. J., Domeisen, D. I., Acharya, N., Adefisan, E. A., Anderson, M. L., Aura, S., ... & Wilson, R. G. (2021). Advances in the application and utility of sub-seasonal-to-seasonal predictions. *Bulletin of the American Meteorological Society*, 1-57.

Young, M., Heinrich, V., Black, E., & Asfaw, D. (2020). Optimal spatial scales for seasonal forecasts over Africa. *Environmental Research Letters*, *15*(9), 094023.

Assessing forecasting approaches

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Putting learning into practice: Tools and guides

Improved tools to enhance resilience

Tools are important for gathering, processing and communicating information to strengthen resilience. This brief outlines how SHEAR projects have generated knowledge through the development and use of new co-designed tools.

User-Centred Design for Disaster Risk Visualisation

There are many widely recognised advantages to communicating information through visualisations. Visualisations improve users' ability to make informed decisions, complete tasks and understand a situation. However, the context within which disaster risk operates is highly complex. This document presents a user-centred design framework that can be utilised to develop visualisations for different user groups and across different disaster contexts.

Visualization of EW messages

There are many widely recognised cognitive advantages to communicating data, information and knowledge through visual representations rather than written or verbal words. Visualisations improve users' ability to make an informed decision or complete a specific task, and can result in better understanding or behaviour changes. This document provides guidance on aspects to consider when designing visualisation of early warning information.

Interdisciplinary collaboration

Learning from SHEAR: Interdisciplinary collaboration

SHEAR projects are designed and implemented as consortia, with partners from diverse institutions and disciplines contributing their expertise. Multi-institutional partnerships help to ensure that research is conceptualized, designed, tested and taken up by critical stakeholders embedded in relevant institutional, political, social and economic systems. This brief outlines learnings relating to interdisciplinary collaboration.

Early Action Thesaurus

As a new way of thinking and acting, anticipatory action comes with a new parlance and vocabulary. This thesaurus is intended to enable reflection on the similarities and differences in the way organizations use language associated with the concept of anticipatory humanitarian action. Its purpose is not to define terms but to facilitate mutual understanding and, thus, coordination and collaboration across the multitude of organizations operating in this space.

A guide to Effective Collaboration and Learning in Consortia

Working in the complex context of climate change adaptation and resilience, individuals and organisations are often required to work together in consortia across disciplinary, institutional, geographical, and cultural boundaries. Working in large consortia offers great opportunities for addressing complex problems. However, diversity of backgrounds and approaches to issues means that joint identification of challenges and solutions can be complex. This guide shares some examples and lessons learnt from a range of consortia operating across different programmes.

Putting Science into Practice for Improved Disaster Resilience

Interdisciplinarity is central to the SHEAR programme, encouraging physical scientists and social scientists to work together with in-country practitioner partners to address natural hazard and forecasting challenges. This snapshot explores experience and learning about bringing together institutions and individuals from across three “pillars” - social sciences, physical sciences, and disaster risk management practitioners - to achieve successful applied research for disaster resilience and response.

Research Roadmap: Forecast based Financing

The objective of forecast-based financing (FbF) is to enhance humanitarian action to protect the lives and livelihoods of the most vulnerable from the effects of weather and climate related disasters. To move forward with this ambitious agenda, there are a number of critical research questions remaining. This roadmap identifies five goals for the success of FbF, lists critical research questions that need to be addressed to help achieve these goals, and identifies several priority research questions related to incentives of different actors.

Interdisciplinary collaboration: Peer reviewed papers

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Governance and policy

Improved decision-making to act in anticipation of hazards

SHEAR worked with stakeholders at all levels and across sectors to improve anticipatory capacities and decision-making processes to enhance action in the face of future hazards. This brief outlines advances made in decision-making for disaster preparedness, response and recovery.

Putting stakeholder needs at the centre

Key stakeholders, including at-risk populations, need to be at the centre of research prioritization, design and delivery. Putting the needs of stakeholders at the centre is critical to achieving programme objectives, and to ensuring long-term sustainability. This brief explores key learning from across the SHEAR programme related to stakeholder engagement.

Lessons for future funding

Effective investment in research can enhance disaster preparedness and resilience, saving lives and protecting communities. This brief explores key learning from across the SHEAR programme related to funding sustainable, high-impact research to improve disaster resilience.

SHEAR Challenges

During the 2022 finale event for the SHEAR programme, SHEAR stakeholders came together to discuss areas of outstanding challenges in impactful ‘research into action’. This brief summarises those discussions, aiming to help identify priorities for future research ensuring subsequent ‘research into action’ programmes build on the learning and advances made in SHEAR.

Policy implications and lessons learned: The Political Economy of Disaster Risk Financing

Moving towards more anticipatory, pre-agreed disaster financing and response is a shared goal for many in the disaster response and humanitarian sectors. This shift is what opens the potential for much more effective disaster response, but it also poses challenges for practitioners around interpretation and decision-making processes. This policy brief provides practical recommendations to navigate some of these challenges.

Governance and policy: Peer reviewed papers

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