**Question (a):** *What has been accomplished as a result of your group’s or project’s international coordination in the domain of Earth-system science that would not have happened otherwise? (for the entire period of the implementation plan and special focus on last year)*

\* Entries marked by a \* delivered benefits during the past year.

\*The focus of weather services is transitioning from predicting hazardous weather to enabling decision makers to respond effectively. HIWeather did not start that transition but is having a major influence on its progress through the activities of HIWeather members, many of whom are influential in their weather services, in weather service capability development projects, and in training the next generation of scientists. The direct influence on weather services has so far been most evident in Australia, the UK, the USA and Argentina. Indirect influence is evident in development projects in countries of East and South-East Africa and of South and South-East Asia and in the increased interest in this area by social scientists in several developed countries.

\*HIWeather is followed by over 300 scientists in 24 countries, who receive the quarterly newsletter and related communications. A much larger group follow the project through social media. More than 200 HIWeather-related papers have been published by HIWeather members and followers since the project started. These, together with a much larger number of relevant papers promoted through the newsletter, have served to reinforce HIWeather concepts amongst its followers.

HIWeather authors published a special issue of the International Journal of Disaster Risk Reduction on weather warning communication, which brought together a range of state-of-the-art research and perspectives on the communication of weather warnings.

Ref: Taylor, A. L., Kox, T., & Johnston, D. (2018). Communicating high impact weather: improving warnings and decision-making processes. International Journal of Disaster Risk Reduction 30, 1-4. doi.org/10.1016/j.ijdrr.2018.04.002.

\*HIWeather contributed to the United Nations Office for Disaster Risk Reduction (UNDRR) Global Platforms (GPs) in Cancun (2017) and Geneva (2019). HIWeather good practice was synthesised into issue briefs and Global Assessment Review papers for the 2019 GP, where they were received by representatives of most weather services and many emergency managers.

Refs: Golding, B., Mittermaier, M., Ross, C., Ebert, B., Panchuk, S., Scolobig, A., Johnston, D. (2019). A Value Chain Approach to Optimising Early Warning Systems. <https://www.preventionweb.net/files/65828_f212goldingetalvaluechain.pdf>;

Fakhruddin, B., Bostrom, A., Cui, P., Yu, L., Zou, Q., Sillmann, J., Johnston, D., Jimenez, V., Ying, E., Chan,Y., Chan, G.K.W., Hung, H., Huang, Z., Wong, C.K.P., Lim, C.K.P., Anuar T., Komoo J.I.K., Schueller, L.,Thiebes, B., Booth, L., Abad, J., Baills, A., Fleming, K., Zuccaro, G., Lian, F., Lucy Jones, L., Han, Q., Shaw, R., Lwasa, S. (2019). Integrated Research on Disaster Risk (IRDR). <https://www.preventionweb.net/files/65873_f301fahkruddinintegratedresearchond.pdf>

\*HIWeather good practice has been incorporated in the WMO Integrated Urban Systems guide parts 1 & 2, is being fed into the update to the WMO Impact-based-Forecasting guide and has informed development of the IFRC Forecast-based-Financing initiative.

HIWeather activities have been integrated into the Integrated Research on Disaster Risk (IRDR) Scientific Programme, co-sponsored by the International Science Council (ISC) and the United Nations Office for Disaster Risk Reduction (UNDRR).

Popularisation of the HIWeather Five-Valleys-of-Death concept has raised the profile of issues of inter-disciplinarity along the warning chain and to the need for partnerships for effective working. Several influential books and papers have referenced or reproduced it.

\*HIWeather was a major influencing factor in developing the UKRI Multihazards and Systemic Risk call (2019). While HIWeather was not the only influence, its contribution was significant: <https://nerc.ukri.org/research/partnerships/international/gcrf/news/ao-ukri-risks/ao/>

\*The UKRI GCRF Living Cities Hub is a major UK ODA project (£20m) aimed at raising resilience to natural disasters in four urban centres: Istanbul, Nairobi, Quito and Kathmandu, involving a large multi-disciplinary team of experts, more than half of which are from institutions in the target cities. HIWeather played a critical role in the formulation of this project during the 2017 Global Platform for Disaster Risk Reduction in Cancun, though the outcomes are now much broader than the scope of HIWeather.

\*HIWeather was influential, amongst others, in the launch of the NOAA-funded American Meteorological Society project to study the Value Chain for weather information in the USA. A member of the HIWeather SG is contributing directly to the work of the project.

HIWeather contributed to analysis of climate change research priorities within the Disasters Research Group of UK Government as part of COP planning and in UNDRR consideration of research priorities of the Global Risk Assessment Framework (GRAF).

\*HIWeather published a survey of operational met services on use of ensembles in tropical cyclone forecasting in 2019. The outcome is that operational met services are more strongly encouraged to make greater use of uncertainty information in ensemble TC forecasts (not just consensus track) and convey that uncertainty to users through products and advisories.

HIWeather launched a challenge to develop and demonstrate the best new user-oriented verification metric. The winning metrics were most likely developed independently of the challenge, but this activity put them in the spotlight and two of the metrics were published in a special issue of MetZ on verification methods. Impact is unknown, but new metrics may have been developed and/or adopted as a result.

The HIWeather Value Chain workshop in Melbourne helped the Bureau of Meteorology to adopt "value chain thinking" in its end-to-end planning and customer focus. BoM might have done this anyway, but the successful workshop certainly helped the process along. The Berlin value chain workshop in 2017 may have impacted participants' organisations in similar ways.

HIWeather facilitated collaboration of BoM & NCAR on fire weather prediction and evaluation leading to methods for more routine evaluation of fire behaviour forecasts and application of new tools for predicting extreme fire weather.

The HIWeather - W2W conference on Predictability and Multi-Scale prediction of High Impact Weather in Landshut in Oct. 2017 provided an important forum for sharing of research.

HIWeather influenced choices of high impact weather phenomena to focus on in the W2W science plan, and to some extent the decision to have a research area on local High Impact Weather. The successful interaction with HIWeather led directly to W2W becoming a WWRP joint project.

\*HIWeather has authored a review of the current status and future challenges in multiscale forecasting of high-impact weather. The paper provides an overview of major issues and challenges for nowcasting and NWP leading to warning of high impact weather.

HIWeather involvement in the Beijing SURF project (Study of Urban Impacts on Rainfall and Fog/Haze), influenced its planning, science, and publication, steering it towards producing useful NWP products for HIW warning and the essential role of km-scale data assimilation and multi-scale forecasting.

\*Several PhD projects have been set up specifically to address questions raised by HIWeather, particularly those in New Zealand and Switzerland looking at issues of communications and understanding of warnings.

\*A Communication Platform for sharing research in warning communication has been created by the New Zealand HIWeather team at <https://hiweathercomms.net/>

\*HIWeather facilitated a collaboration between the University of Leeds and the Met Office in the UK, which led to a joint post-event study of Storm Doris, published in 2019.

\*An overview paper on the warning chain, based on the 2018 HIWeather workshop, was published in the journal Science Bulletin. Ref: Zhang, Q., L. Li, B. Ebert, B. Golding, D. Johnston, B. Mills, S. Panchuk, S. Potter, M. Riemer, J. Sun, A. Taylor, S. Jones, P. Ruti, and J. Keller, (2019). Increasing the Value of Weather-Related Warnings. Science Bulletin 64(10):647-649 <https://doi.org/10.1016/j.scib.2019.04.003>.

An initiative in citizen science has been started as a result of the HIWeather collaboration.

A book is under preparation to deliver the good practice identified by HIWeather to emergency management professionals.

*Question (b): What have been the collaborative activities with other groups and projects (within and outside WWRP) you are busy with or have implemented?*

**SERA**: HIWeather and SERA have worked closely, particularly on production of the special issue on Communication and in running the value chain workshops.

**FVR**: The user-oriented verification challenges were initiated by HIWeather and carried through by JWGFVR. There will be a joint session between IVMW-Online and the 2020 HIWeather workshop.

**DAOS**: Through co-chair Golding, discussions have taken place on how to promote more research on the specific challenges of km-scale data assimilation for high impact weather prediction. We plan to have a joint session at the next DAOS conference.

**TMR**: Ajit Tyagi has recently been identified as contact in WGTMR. Links are in the process of being established with relevant task team members. One or more joint sessions may be organized at IWM-7.

**WGNE**: We now have WGNE representatives on the HIWeather SG. No specific new joint activity has been identified yet.

**ET-IBFW**: HIWeather members are contributing to the Communication and Value sections of the update to the WMO IBFW guide.

**ET-UIS**: Through co-chair Golding, HIWeather contributed substantially to the guide on integrated urban forecasting.

**IRDR**: Through co-chair Johnston, HIWeather and IRDR work closely on areas of common interest.

**Risk-KAN**: Co-chair Golding has been working to establish a relationship between the Risk-KAN and HIWeather, focused on how to deal with compound risk in warnings. A proposal is with WWRD to establish a formal link.

**Tomorrow’s Cities**: Through co-chair Golding, HIWeather is involved in this multi-national project to build disaster resilience in Nairobi, Kathmandu, Quito and Istanbul.

**Natural Hazards Partnership** (UK): Several members of HIWeather are involved in this partnership which is developing a structured approach to impact modelling in support of impact-based warnings in the UK. HIWeather members are involved in similar, if less formally defined, collaborations in several countries.

**Waves to Weather** (Germany): Through the Processes & Predictability team lead Michael Riemer, HIWeather is involved in several aspects of the W2W programme.

**WCRP**: HIWeather has engaged with GEWEX and the Extremes Grand Challenge through co-chair Golding to ensure that process understanding is incorporated in assessments of changing extremes and to exchange good practice in communication of risk.

**UNDRR:** HIWeather worked closely with UNDRR to formulate the issue briefs for the MHEWC conference in 2019.

*Question (c): How did you implement/address the recommendations from the SSC meeting in 2019? And what will be your priorities up to 2023 (remainder of the implementation plan)?*

1. To encourage research on how to measure the impact/effectiveness of all parts of the warning value chain;

**The end-to-end post-event evaluation database is aimed at gathering information to support studies in this area. HIWeather was also influential in the decision by AMS to initiate a special project on economic valuation of weather services. Measurement of each part of the warning chain will be included in the HIWeather book: “Towards the perfect warning”.**

1. To encourage public to join citizen science project;

**Currently, the focus of the citizen science project is to promote participation by scientists working in this field so as to develop guidance, training and best practice. HIWeather endorsement of relevant citizen science projects may help to encourage wider participation.**

1. To identify outcome/s which could be uniquely attributed to the project and how it has made a difference in its 4.5 years existence;

**See answer to question (a) above.**

1. To organize a HIWeather-led Workshop with WWRP WGs (SERA, FVR, NMR, DAOS & PDEF) on the 4th quarter of 2020 focused on the use of unconventional observations in all parts of the warning chain. This workshop will held be in conjunction with the HIWeather SG meeting for 2020;

**The request for a planning telecon between the groups received only one response and so was abandoned. DAOS and NMR ultimately expressed interest in a joint event of some sort, but due to COVID-19 it was agreed not to attempt a workshop in 2020. Instead, HIWeather will take part in the DAOS/NMR workshop on “Evaluation and improving design of DA for ensemble forecasts using convection-permitting models and novel observation systems” in September 2020, will invite representatives from other WGs to participate in its 2020 online workshop in December 2020, one day of which is specifically on the citizen science theme, and will promote joint sessions at relevant 2021 WG conferences.**

1. To organize HIWeather Steering Group (SG) meeting in Oct 2019; **A SG meeting was held in Geneva on 14-16 October 2019.**
2. To strengthen relationship with SERA in creating improved information content and outcomes related to protective decisions in the face of high impact weather;

**SERA works with HIWeather through current and past SERA members’ contributions to HIWeather task teams. An inquiry to SERA as to whether this could be done better did not result in any response. HIWeather will collaborate with WGSERA in its study of value chains.**

1. To restructure its strategy in order to focus on delivering tangible and significant results that substantially improve the quality of hazard information that is delivered to a variety of constituencies, and demonstrate outcomes from this information that are uniquely attributable to the efforts of HIWeather in conjunction with WWRP Working Groups;

**The HIWeather SG meeting in October 2019 reoriented the HIWeather strategy to focus on three projects: (i) a project to promote and develop the use of citizen science (ii) a project to create a database of post-event evaluations of the end-to-end performance of warning systems (iii) the synthesis of HIWeather best practice into a book aimed at professional emergency managers.**

1. To invite a WGNE rep to be a member of the HIWeather SG;

**Ron McTaggart-Cowan and Ariane Frassoni have joined the SG as alternate WGNE representatives.**

1. To schedule a telecon involving WWRD chief, Mr C. Davis and Ms C. Vogel to discuss possible collaboration between HIWeather and Risk KAN.

**The telecon was held in April and led to the preparation of a formal proposal, which is currently being considered by Chris Davis, Coleen Vogel and Paolo Ruti.**

**HIWeather priorities in 2020-2023 will be**

1. To develop the citizen science initiative beyond providing guidance on good practice in 2020 into demonstrating its contribution to building resilience to high impact weather in 2021-3.
2. To finalise the end-to-end case study proposal and get it funded in 2021, then to implement it and to carry out research using the resulting database in 2022-23.
3. To publish the book “Tomorrow’s warnings” in 2021.
4. To work with DAOS and NMR to promote and deliver an activity to improve multi-scale data assimilation, starting with a joint workshop in September 2020, “Evaluation and improving design of DA for ensemble forecasts using convection-permitting models and novel observation systems” and including a joint session at the DAOS workshop in 2021.
5. To complete the review of impact prediction by the end of the period.
6. To develop a collaborative activity with the Risk-KAN on communicating warnings of compound risks, starting in 2021.
7. To collaborate with the SURF project and WGNMR in the application to high resolution NWP to high impact weather in preparation for the Beijing Winter Olympics in 2022.
8. To complete the work on “trust” in the Communications task team with a publication.
9. To deliver the second user-oriented verification challenge in collaboration with JWGFVR.
10. To hold a second joint workshop with W2W.
11. To hold joint sessions on unconventional observations with other working groups as agreed – currently NMR, TMR and DAOS are being planned and we would also aim to be involved in the related SERA and FVR sessions at their workshops/conferences.