Open source monitoring and forecasting of drought: ***decision support by farmers, for farmers.***

Our objective is to work with agricultural partners and schools in sub-Saharan Africa to increase the distribution of open source weather stations (FreeStations) using novel, low-cost sensors, and make primary and secondary (i.e. modelled) information generated by these stations readily accessible to farmers as drought and irrigation relevant forecasts through a text-message based tool, WaterWorld mobile. We will deploy FreeStation weather stations in spatially dispersed sites and test the utility of text message based access to drought and irrigation alerts with at least 100 farmers and extension workers. The stations will monitor weather, soil moisture and water depth, feeding data by 2G GSM in near real time to the widely used WaterWorld Policy Support System (> 1,200 organisations in 141 countries), a process-based hydrological model that can support hydrological analysis and decision-making. From here the data are combined with near-real time remote sensing to calculate a series of drought risk and crop and soil specific irrigation scheduling metrics and make these available to farmers as text messages thus providing locally relevant *nowcasts* and short term forecasts of soil moisture and reservoir levels. This will: increase the availability of data for crop insurance purposes, provide information for irrigation scheduling that supports production of diverse species and varieties, and help farmers to better manage harvests and drought.

Ground based monitoring infrastructure of essential climatic variables is declining globally and where ground-based weather stations exist they are typically costly to maintain and their information rarely accessible to smallholder farmers. The FreeStation initiative addresses this challenge by using open source hardware and software to build automatic weather stations with the lowest cost, easiest transport, most accuracy, greatest robustness and easiest build possible. These stations are provided to local organisations free of charge to facilitate the accessibility of reliable, detailed and local climate data in areas that may have little financial and technical capacity for the collection of such data.

Hypothesis

We hypothesise that i) removing commercial and technological barriers to environmental monitoring will improve its use by farmers in minimising drought related crop hazards; ii) farmers and schools are good custodians of environmental monitoring tools and, with well-designed technology and training, can maintain and build their own monitoring networks; and iii) providing relevant drought risk and irrigation advice can improve farmers' ability to manage drought and associated losses.

The team and key to success

The project team consists of Bioversity International (Sarah Jones and Yosef Gebrehawaryat), King's College London (Arnout van Soesbergen and Mark Mulligan) and Universidad del Valle (Jorge Rubiano) who all have successfully partnered in previous and ongoing research with smallholder farmers using FreeStations and WaterWorld. We will ensure early and ongoing engagement with local schools,

universities, meteorological offices, agricultural ministries and irrigation managers to maximise the reach and impact of the project and data it generates. We will work closely with the Trans-Africa HydroMeteorological Observatory (TAHMO) to install FreeStations in locations that complement their network, co-sharing weather station data, and seeking TAHMO input to further design and testing of WaterWorldmobile so that findings can inform development of an Africa-wide advice and alert system.

Piloting

We will focus the project in Bioversity focal areas in dryland Africa, where agricultural water management is a high priority, targeting locations with scarce ground-based station coverage as indicated by the TAHMO and National Climatic Data Centre networks. These tentatively include Ethiopia and Zambia. We will install 15 FreeStations across these countries in farmer fields, grazing lands, and small reservoirs used for irrigation, to allow for comparison of data and maximize its utility to farmers across these productive systems. In collaboration with agricultural ministries, we will pilot with 10 extension workers and 90 farmers a text message based near real-time agricultural advice and alert information system called WaterWorld-mobile, that will provide location based outputs by coupling monitoring, models and remote sensing. Participants will be selected by random sampling within agricultural regions stratified by poverty level to ensure that some of the most vulnerable farmers are included. Anticipated and actual use of the provided data will be assessed through a mobile-based questionnaire and use will also be monitored through click-counts.

Budget and timetable

Costs include development time for server side collection of remote FreeStation data and processing ($30,000), stakeholder engagement in each pilot country including two FreeStation demo workshops ($25,000), materials and support to local institutes to enable installation of FreeStations and piloting of WaterWorld mobile system ($30,000), and impact assessment ($15,000). Priority will be placed on installing FreeStations and developing the data processing and advice and alert system during the first 6 months of the project and piloting the system with farmers during the second 6 months.

Essential data

FreeStations installed on this project will collect hourly data on temperature, precipitation, humidity, solar radiation and soil moisture (for stations installed in farmer fields) and water depth (for stations installed in reservoirs) in currently data-scarce regions. Users of these stations will be able to read the data from a graphical screen display showing trends over the last few weeks. Data will be sent to WaterWorld via GSM and combined with earth observation data to generate forecasts of soil moisture and reservoir water levels. The nowcasts, forecasts and agriculturally and hydrologically relevant analytical derivative data will be made available to farmers through WaterWorld-mobile and online where any user can access the raw data and graphical summaries of recent climate variables.

Next steps

We are keen to scale up by deploying more FreeStations and developing the system, to i) create a more comprehensive monitoring network and increase the number of farmers that can access it; ii) provide farmers with data on which crop species, including neglected and under-utilised species, are suitable to which soil and climate type; and iii) expand the system for use in other geographical regions where farmers may have different water resource and agricultural management issues.