BEYOND CLIMATE FORECASTING OF FLOOD DISASTERS

C.J. STIGTER\textsuperscript{1)}, H.P. DAS\textsuperscript{2)}, V.R.K. MURTHY\textsuperscript{3)}

\section*{INTRODUCTION}

The motivation for this lecture was a newspaper item from Japan on shifting away from predicting earthquakes to other ways to prepare potential victims (Anonymous, 2003a). The argument of the Central Disaster Management Council, chaired by Prime Minister Junichiro Koizumi, was that measures to accurately predict earthquakes remain elusive. It was therefore considered a better policy (in this case for the Tokai region, Japan) to deal more directly with the consequences of what many feel that is inevitable, a major earthquake.

As one of us did already in a message posted on the web site of the International Society for Agricultural Meteorology (Stigter, 2003a), we want to put forward the opinion that dealing with flood disasters would gain from the same change of emphasis in the approach. Because we are agrometeorologists we want to deal with these matters as far as their agrometeorological aspects are concerned.

From the beginning it should be clear that, as in the case of the earthquake predictions in Japan, warnings based on possible weather and climate forecasting of floods should not be abandoned. However, the reliance on forecasting will diminish because of the state of the art and the obvious difficulties involved. Additional measures have to get focus and different questions will have to be asked with respect to preparing victims for the occurrence of floods.

\textsuperscript{1)}Founding president, International Society for Agricultural Meteorology, Wageningen University, Wageningen, The Netherlands (kees.stigter@wur.nl & cjstigter@usa.net)
\textsuperscript{2)}Collaborator, International Society for Agricultural Meteorology, Meteorological Office, Pune, India (hpdaag@hotmail.com)
\textsuperscript{3)}Elected correspondent, International Society for Agricultural Meteorology, Acharya N.G. Ranga Agricultural University, Hyderabad, India (vrkmurthy11@hotmail.com)
APPROACHING FLOOD DISASTERS

In a recent paper on using traditional methods and indigenous technologies for coping with climate variability, Stigter et al. (2004) indicate that with respect to response strategies with agrometeorological components, as to floods the existing technological literature is not abundant.

Several simultaneous approaches with agrometeorological components, to diminish the occurrence and decrease the seriousness of flood disasters for agricultural production, do these days exist. Protecting and restoring soil cover and blocking run off water by all possible means, to diminish and slow down run off, is the best known attack in places where due to lack of land hilly areas have to be exploited (e.g. Grimshaw and Helfer, 1995; Zhang et al., 2003; Kinama et al., 2004). Tracking and quantifying soil erosion patterns in the field in simple ways, to get a better basis for soil and water conservation measures, is a more recent approach in farmers’ fields (Herweg, 1996).

Weather systems monitoring, rainfall monitoring and river flow monitoring for agricultural and other purposes as well as related early warning approaches are playing a role in warning (and therefore preparing) farmers as well as inhabitants of urban areas for floods (e.g. Istiqlal Amien, 1997). Although there is much potential support for giving priority to their implementation, even when followed by advice on the use of that information they have obvious limits in mitigating the consequences of such disasters without improved risk assessments (Stigter et al., 2000).

One step beyond this short time preparedness, climate forecasting should influence decision makers in agricultural production and their advisors (e.g. Salinger et al., 2000). This applies in particular to the kind of IPCC warnings for increasing climate variability and climate change, predicted to lead in many places to more, and more serious, extreme events such as floods. However, most predictions of this type are not very location specific, neither in time nor in space, whether general in character or seasonal.

The next step, beyond forecasting, is therefore to increase the resilience of farmers with measures -- for us with agrometeorological components -- that diminish yield disasters from floods and protect from degradation the agricultural resource base needed for a sustainable agriculture, often with low to medium inputs.
However, we should ask ourselves first why in agrometeorology so little of this kind of preparedness measures can be found.

**A DIAGNOSTIC CONCEPTUAL FRAMEWORK FOR GENERATION AND TRANSFER OF AGROMET SERVICES AND INFORMATION**

At several occasions Stigter (e.g. Stigter, 2002; Stigter, 2004) used a diagnostic and conceptual framework to explain the lack of operational agrometeorological services and information that make a difference in the livelihood of farmers, as represented in Figure 1.

Of the three action domains of agrometeorology distinguished in that framework, the A-domain is that of the livelihoods of farmers, where the actual agrometeorological services should be provided and agrometeorological information should be applied. And the C-domain is that of the support systems to agrometeorological services, which are represented by (i) data, (ii) basic research, (iii) education/training/extension and (iv) policies.

Between these domains we have plotted a B-domain that contains, like in solving mathematical problems, the initial conditions and the boundary conditions necessarily to be satisfied for solving problems with agrometeorological components in the livelihood of farmers. The B domain has three components, none of which can be neglected without jeopardizing any possible solution of the agricultural production problems concerned.

The first part of the B-domain is formed by the best and still useful local adaptive strategies applied by farmers, that contain the knowledge pools based on traditional knowledge and indigenous technologies based on innovations from within the farming systems concerned. The second part consists of well-selected contemporary scientific and technological knowledge pools that all sciences have to offer. The appropriate policy environments for problem solving in agricultural production compose the third part of the B-domain. Norse and Tschirley (2000) have indicated that in a new paradigm of science these policies should be based on scientifically supported social concerns and environmental considerations, operating through the markets where this is appropriate.

Going from the C-domain to the B-domain involves an upgrading of the operationability of the scientific support systems. This upgrading is driven by agrometeorological action support systems on mitigating impacts of disasters. I
have called these in a recent policy paper for WMO/CAgM (Stigter, 2003b) our good intentions, translated in the development of monitoring systems, early warnings, forecastings etc. (E1 in the framework of Fig. 1).

However, as everywhere in life also here good intentions are not enough. We need to go from the B-domain to the A-domain in another upgrading of the operational use of science, taking care that for each agricultural production problem to be solved the right mix of ingredients, from the three components of the B-domain, is (made) available.

Any missing ingredients should lead to feedback back into and from the A-domain for better articulation of existing adaptation strategies and innovations and into and from the C-domain for improvements from the support systems concerned. The driving force here, between the B-domain and the A-domain, is the provision of agrometeorological services supporting actions of decision-makers in agricultural production (E2 in the framework of Fig.1).

USE OF THE FRAMEWORK TO UNDERSTAND THE SITUATION OF AGROMETEOROLOGICAL COMPONENTS OF FLOOD DISASTER MANAGEMENT

Literature used earlier
The framework illustrates why there is a need for an approach “beyond forecasting”. Yes, we have to strengthen and improve monitoring, early warnings, forecasting etc., but they have their limits, even when we go beyond the good intentions of the E1 efforts. However, for example microclimate management and manipulation, through permanent interventions with windbreaks, shelterbelts, mulches, shades and other surface modifications, as in some forms of multiple cropping, give some permanent degree of protection from certain strong weather and climate events (Baldy and Stigter, 1997; Stigter, 1999). Their design belongs to agrometeorological services (Stigter, 2004). There are also other possible measures decreasing vulnerabilities of farming systems for flood disasters in the A-domain, but they are less in number and much less applied (e.g. Berg et al., 2001).

They may range from crop insurances to a choice of crop varieties less affected by certain extreme events. And from contingency or relief measures organized by the government - to assist farmers in re-organizing themselves when weather & climate strike - to other agrometeorological services that diminish and mitigate the impacts of extreme events in the livelihood of farmers (e.g. Jager and Ferguson,
1991). Stigter et al. (2004) quote Cheng Yanian reporting traditional drainage ditches and tunnels that are used in wheat fields in China, typically an example from the A-domain.

They also indicate that evaporation through reforestation by water absorbing trees, that also may occasionally enhance soil conservation and soil shading, may play a role. Ecological restoration of flood damaged areas by agroforestry, afforestation and reforestation is more often involved (MOST/CIRAN: running database; Salinger et al., 2000). Grasses may be involved in an early stage (Zhang Yingcui, personal communication, 2003). This is what Salinger et al. (2000) have called “extension through permanent (weather) advisories on farming, production and cropping systems, in accordance with the possibilities for change in the different farming communities”. This flood impact reduction applies to techniques of using inputs, soil conditions and planting densities, choices of cropping systems and varieties, applications of (improved) protection strategies in crop/tree space and applications of other multiple cropping microclimate management and manipulation techniques. Here everywhere the B-domain is at work for deliverance into the A-domain.

New literature search
From a literature search undertaken for this paper, it is clear that flood hazard maps are essential tools for land use planning (e.g. Jeyaseelan, 2003). They appear often unsuccessful (e.g. Robert et al., 2003). However, when followed up by actual management decisions on land use, these monitoring exercises are invaluable (Stigter, 1994). As in many other cases of natural disasters, below we talk about flood prone areas that nevertheless have to be used for agricultural production. It must also be clear that such calamities as for example happen in China around its Yangtze river with a not negligible frequency can hardly be met with any production preparedness while on the other hand annual flooding can be agriculturally used (Winchester, 1996).

In a report by Doctor et al. (2000) on the consequences of the October 1999 Orissa supercyclone, the situation is well reviewed. Firstly it is concluded that trying to build preparedness models may be counterproductive because of the occurrences and effects being extremely location specific. This is in line with many earlier conclusions in agricultural climatology (e.g. Stigter et al., 1992). Secondly, the lessons learned from very exemplarious villages fitted in three categories: livelihood-focused support, participation and community perspectives, all in my A-domain and part of my B-domain.
Preparedness through the immediate availability and provision of familiar livelihood-focused traditional varieties of inputs appeared to be one clue, if the villagers had indicated in advance that this was their choice in case of catastrophe striking. Participation in organizing themselves as a community before any disaster was the second key factor, if such organizing power was indeed used immediately before and after any calamity. It was under the community perspective that local NGOs, farmer organizations, youth and women groups could be involved and lessons could be translated into day to day life and livelihood systems.

In the above context only little additional information was found with agrometeorological components. And if so, this was always in cases of less serious flood conditions and mostly based on traditional knowledge and indigenous techniques and innovations.

Where lack of natural and artificial drainage causes large areas in India and elsewhere to suffer from water congestion (Jeyaseelan, 2003) due to high rainfall, flat topography and poor water transmission characteristics in the soil profile, surface and sub-surface drainage have been proven to create yield improving solutions (e.g. Devadattam, 1995). Other examples come from Zimbabwe (Robertson, 1964), Brazil (Lal, 1985), Portugal (Sims, 1983) and again India (Krantz, 1981).

One example of better preparedness with respect to abundant rainfall related to cyclone disaster was found in the suggestions made by prawn growers in India including raising and strengthening of bunds, improvement of drainage facilities and reduction of water levels in the ponds (Prasad, 1998).

Green belts are known to reduce the impact of flooding, and beneficial vegetation in flood-hazard areas and/or upstreams is preserved or improved by reforestation or by erosion and flood preventing growings of grasses and trees/bushes on hill slopes and terrace raisers (Lal, 1987; Grimshaw and Helfer, 1995; Istiqlal Amien, 1997).

But where to find more improvements for flood damage mitigation? The most obvious improvements are flood water detention or flood diversion attempts for agricultural purposes (Evenari et al., 1982; Abdalla et al., 2002). However, if crops are flooded, outlets and drainage have to be provided. We should find crops that can tolerate complete water saturation longest. Because crops appear less affected when there is a slow continuous passage of water than if water is stagnant (Michelson et al., 1965), such conditions should be created. And crops least vulnerable to mechanical damage by flood water should be selected the same way
varieties can be found that are less vulnerable to lodging and other cyclone damage (Suresh Kumar, 1994).

Such work we did not encounter. We did, however, come across a plea for further using of “surface contact” cover crops (Lal, 1987). Surface contact cover is that cover which is so close to the soil surface that this distance is comparable to the depth of water flowing over the surface. In agricultural systems, this contact cover can be provided by creepers or by residue or non-harvested components of a previously grown crop, as physical soil protection. This has a striking similarity with soil protection from wind erosion (e.g. Zhao Ju et al., 2003).

A serious effect of floods are landslides. The counter-measures to be taken in advance demand for direct expenditures in civil engineering but may also compete with agricultural land. In such cases priority should be given to the engineering aspects although keeping enough good quality land for agricultural production has been recognized as a priority policy issue (Stigter et al., 2000).

Another aspect that might be considered in preparedness is related to the influence of flood water on the nutrient conditions of the soil (Ludwick, 1997). Nitrogen in the form of nitrate is either leached away or denitrified. Prolonged wetting slows decomposition of organic matter in and on the soil (mulching) as a source of N for crop use down. Phosphorous is lost by water erosion of top soil, reduced microbial activity in saturated soil reduces P availability and depressed mycorrhizae due to flooding decrease P absorption by roots. More flooding related effects affect P. Potassium (and other nutrients) availability is reduced by compaction, so working too wet soils may be disastrous. Such K availability is for example particularly important for perennials weakened by prolonged flooding and especially prone to development of disease problems, which are reduced by potassium (Ludwick, 1997).

Although these facts come from a paper on fertilizing after floods, the above and related knowledge could possibly deliver a strategy for nutrient management of various types of soils and farming systems before the start of recurrent flood seasons, that would reduce negative aspects on soil fertility. Knowledge is power. Each field of science can make a contribution to better preparedness.
FINAL DISCUSSION

Did we do well by comparing better preparedness for flood disasters with agrometeorological components with the recent new earthquake approach from Japan? Floods are not comparable to earthquakes. Or are they?

Let’s take a message from “The new Indian Express” daily (Anonymous, 2003b) on a cloudburst claiming at least 150 lives in Himachal Pradesh. This is a sudden and violent rainstorm falling over a short period of time and confined to a limited area. The catastrophic force with which the large volume of water hits the ground results in flash flooding of the area and causes massive devastation. It is like a wall of water coming down, due to clouds laden with moisture getting trapped in a valley in mountainous regions. Vertical upward movements within water-laden clouds cause falling curtains of water. This cloudburst phenomenon very much sounds like an equivalent of a small earthquake. It is well known that particularly short-time floods are caused by rare single events (e.g. Herweg, 1996). Sudden large-scale floods have the same inevitability as earthquakes.

We are aware that just like earthquakes have the open scale of Richter, floods could have such a scale. The above cloudburst catastrophes would have a high number on such scales even if the area affected is small, and so would the Orissa supercyclone related water induced damage and the Yangtze floodings. Other examples dealt with above would have a much smaller number but can still have locally devastating effects.

Beyond agrometeorology the preparedness plans in Japan also sound very much applicable to flood disaster situations. The Council’s plan also calls for a system that ensures relief goods and personnel and Defense Forces from other parts of the country can smoothly reach stricken areas. Priority in reconstruction efforts should focus on resuming main transportation routes, ensuring supplies of water, electricity and gas and to clear away rubble (Anonymous, 2003a). Local governments have to take steps to examine certain preparedness standards, redrawing their present status.

In many places we found insurances mentioned as a preparedness factor. However, private insurance makes only sense when a limited number of victims can be compensated from money contributed by many that were spared. In cases of large scale disasters, insurance is just another form of relief compensation that can only be provided by government or charity. Damage limitation by all means of better preparedness is a more feasible approach. Also support systems in agricultural
meteorology should contribute to create services with agrometeorological components preparing farmers much better for damage reduction to crops and resource base before floods strike.

We should collect case studies in which better (for us agrometeorology related) steps, with a small cost benefit ratio, have been successfully taken to reduce damage to agricultural production in flood disaster preparedness management. It is likely that with such examples available, governmental and non-governmental organizations will be encouraged to recognize how much is at stake and how much can be saved by their own production related preparedness and that of the population at large each time that floods strike.

References


MOST/CIRAN, running database. Ecological restoration of degraded watershed on the upper eaches of the Minjiang River; Integration of Qiang ethno-botanical knowledge and practices into a reforestation project. CHINA, BP.15, Best Practices on Indigenous Knowledge Database, [http://www.nuffic.ciran]


Stigter, C.J., 2002. Opportunities to improve the use of seasonal climate forecasts. Part of Lecture Notes for an Asian Climate Training Workshop on “Climate Information Applications”, Asian Disaster Preparedness Center (ADPC), Bangkok, Thailand, Bullet Points + 18 pages, available on CD-ROM.


A = Sustainable livelihood systems

B = Local adaptive strategies (knowledge pools based on traditional knowledge and indigenous technologies) + Contemporary knowledge pools (based on science and technology) + Appropriate policy environments (based on social concerns and environmental considerations, scientifically supported and operating through the market where appropriate)

C = Support systems to agrometeorological services: data + research + education/training/extension + policies

\[ A \leftrightarrow \quad \quad \rightarrow \quad B \leftrightarrow \quad \quad \rightarrow \quad C \]

| E2 | E1 |

E1 = Agrometeorological Action Support Systems on Mitigating Impacts of Disasters

E2 = Agrometeorological Services Supporting Actions of Producers