Early Warning Saving Lives

Establishing community based early warning systems in Nepal. Learning & Experience 2002-08

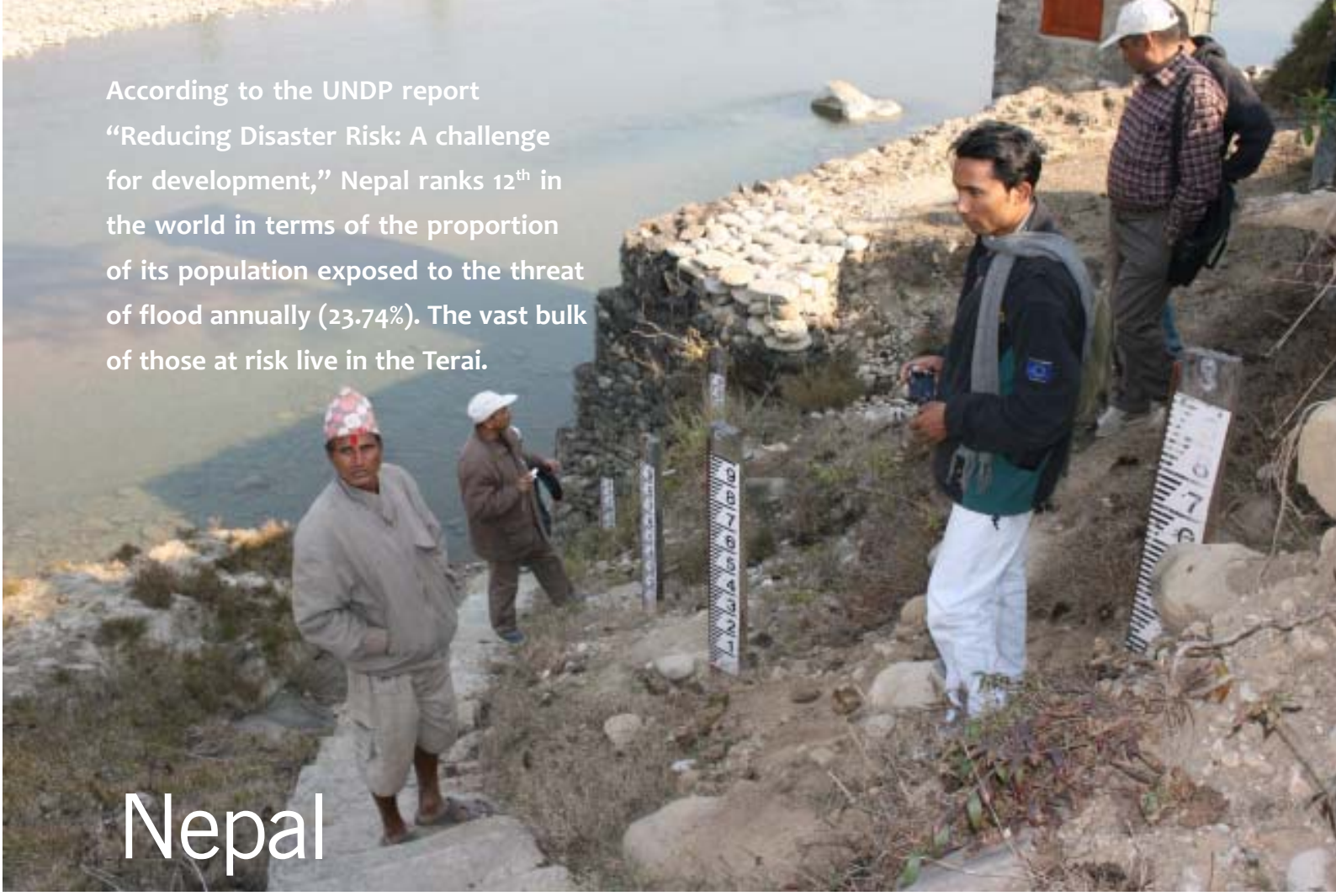
PRACTICAL ACTION
Technology challenging poverty

Practical Action has been working on community based EWS (early warning systems) in Nepal since 2002 - specifically on systems which give early warning of flood. As a result of its own learning, on-going community feedback, and "real time" evaluation, Practical Action has become convinced of a number of key issues.

- Investment in EWS is a cost effective use of limited resources where risk can be anticipated and measured. Vulnerable communities have a right to such warning.
- High tech/high cost systems are not only inappropriate but unsustainable. Use of local resources both cuts costs and ensures greater ownership.
- Systems should provide information, not warnings *per se*. Making information intelligible and user friendly are fundamental to any system.
- Users of information should be active participants in systems, not beneficiaries of them. Systems must be established which put users first and at their centre.
- Systems should be based on the principal of "demand for", not "supply of" information.
- Successful EWS are the product of effective person to person communication and efficient social networks. Communication technologies merely complement these.
- Systems should dictate the technology and not technology the system.

We hope this publication helps summarise Practical Action's learning in EWS and offers practical insight in to how such systems can be replicated and developed elsewhere. We encourage you to make use of the information included on the enclosed CD/DVDs as limited space has precluded the sharing of all the information available in one publication. Additional information can also be found at **www.practicalaction.org/earlywarning**

CONTENTS



According to the UNDP report "Reducing Disaster Risk: A challenge for development," Nepal ranks 12th in the world in terms of the proportion of its population exposed to the threat of flood annually (23.74%). The vast bulk of those at risk live in the Terai.

Nepal

Globally, Nepal is perhaps unique in the diversity of its topography and geography. For many synonymous with the high peaks of the Himalayas just under 50% of its population actually live in the flat plains of the Terai, a region running from one end of the country to the other parallel to the Indian border. Though occupying only 17% of the country's land mass the Terai is responsible for the bulk of the country's agricultural output, supports the main communication and transportation arteries, and carries its major river systems.

Watered by three major river systems, the Kosi, Narayani and Karnali, the population of the Terai are exposed to floods annually, the impacts of which have grown in severity and regularity in recent years. The reasons for this are many, with climate change often cited as the most critical, but in truth the area has experienced massive population growth and intensification of agriculture over the last 50 years, to the extent that cause and effect are blurred. Perhaps the reasons are not so important, given that the impacts are so clear?

For hundreds and often thousands of people each year monsoon related floods result in massive loss of property, erosion of land, destruction of irreplaceable assets, death of live stock, spoiling of stored food stuffs and ultimately, loss of life.

Hand in hand with this exposure to risk, Nepal suffers from low levels of electrification, poor telephone connectivity, a meager and seasonally disrupted road network, political upheaval which has only recently moved beyond the stage of open conflict, ethnic, religious and linguistic division and an only slowly expanding economy.

In this context, it is not surprising that the resources available to government authorities for development activities are limited, with post emergency relief being a major budgetary priority in endemically flood prone areas. In recent years however the Government of Nepal has begun to prioritise DRR (Disaster Risk Reduction) and preparedness activities, signing up to the Hyogo Framework for Action (HFA) in 2005 and moving towards initiating a new National Disaster Management Strategy, Policy and Act during 2009, all of which will incorporate DRR.

Within these the role and importance of effective EWS is a stated priority.

"If we can get information before the floods come, it will save our lives. We may not be able to rescue everything, but our children and families will be saved"

– Shri Ram, Holiya

Theory

The literature of early warning uses a number of different terminologies and classifications for the stages necessary to establish EWS. Broadly speaking however they can be summarised as:

1. Risk awareness
2. Monitoring and warning
3. Dissemination of warning
4. Community response

In relation to flood risk in Nepal the present situation probably differs little from that in many developing countries.

Risk awareness

At the national level many hazard studies and ranking exercises have been carried out with a growing number of area or sector specific risk assessments being supported by NGOs and research organisations over the last decade in particular.

At community level awareness levels vary widely, so that while urban populations have a growing awareness of earthquake risk issues – through the running of public awareness and mass media campaigns – rural populations have far less awareness or understanding of flood or landslide risk. Awareness levels are rising, but from a very low base.

Raising awareness in Banke and Bardia.

Practical Action were aware that awareness campaigns had been run previously in Banke and Bardia, but these had only really been run through FM radio, tended to be 'generic' in nature and were solely in Nepali.

In an ethnically and linguistically diverse area the need for multi language materials and content was clear, not just so information could be understood but also so it would be accepted. The need for more specific information was also identified if communities were to be taken beyond the stage of mere "awareness" to genuine understanding.

As such radio "jingles" were supplemented with interviews and discussions on air, with these being broadcast in Tharu and Awadhi languages as well as Nepali, to appeal to the larger minority groups in the area. These specifically focused on the issue of flood, its causes and effects.

At the same time community level awareness campaigns took place, in the form of three rounds of house to house distributions and discussions led by women's groups over a period of several months.

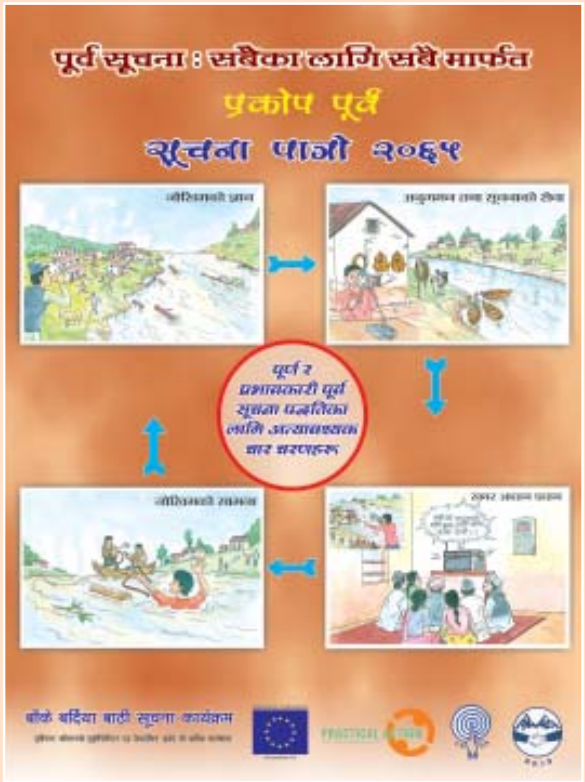
Firstly posters were distributed. These used imagery familiar within the Terai incorporated into pictures highlighting typical stages in flood preparedness, warning and response. These images were complemented with captions in three languages.

A distribution of 6,000 calendars then built on this, by incorporating these images within the four stages necessary to establish a successful EWS, highlighting in particular the routes through which warning could be communicated. The calendars also carried critical district emergency telephone numbers and photographs of the actual upstream monitoring stations used in the EWS to assist familiarity with the warning system at the household level.

Finally leaflets were given out explaining the specific warnings and what people should do on receiving them.

Prior to these material distributions wall paintings, song competitions, street theatre, and schools art and essay competitions were used to highlight what could be achieved if communities could get some warning.

None of these activities were new or unique, but the fact that they took community members past the stage of mere "awareness", to understanding and action, was critical.



It is interesting to note that this was the first time that Biraha (Awadhi) and Kathaura (Tharu) song competitions had been used for public awareness purposes and that it helped revive what were becoming forgotten cultural practices.

Monitoring and warning

At the macro level the DH&M (Department of Hydrology and Meteorology) is linked into regional monsoon forecasting systems – which give broad brush stroke information on rain likelihoods, duration and intensity, and has a specific section for flood monitoring & forecasting. To support this a network of monitoring stations covering all the major river systems was established in 1987 using HF radio to report water levels. A wireless data transmission system has also been in operation on the Narayani river system since 2007. While historically data gathered has been used mainly for long-term planning purposes, commitment now exists that this type of information should be used for the benefit of ordinary people, through more active dissemination.

Dissemination of warning

This represents the biggest challenge for Nepal at the moment - bridging the gap between those with information and those who do not, along with bridging the gap in terms of making information intelligible and accessible to ordinary people. At present very little has been done, with the small investment in EWS to date being primarily for the protection of infrastructure, not people.

> ***....it is not only this year. We were interested in disseminating information on rainfall and river levels in previous years as well, but in those days such a system didn't exist.***
>
> – Prakash Chand, news coordinator of Bageswori FM

Community response

Many NGOs in particular are actively engaged in DRR activities in Nepal. These have spread the understanding and practice of numerous risk reduction and capacity building activities, to the extent that many risk prone communities are now well versed in the language and methodologies of VCA (Vulnerability Capacity Assessment) and CBDM (Community Based Disaster Management) planning. As such the ground is well prepared for the introduction and/or incorporation of EWS in to on-going DRR programmes.

In Nepal most inputs to date have been put in to the highest and lowest levels of the process, so that while awareness has been raised and community capacity increased, there has been little investment at the intermediate levels.

It is at these levels where the greatest gaps exist and where Practical Action has been concentrating its activities.

1. The monitoring and communication of real time risk information – primarily by and from formal institutions – in a meaningful, timely and understandable way to communities.
2. The dissemination of that warning at and through community structures.

> ***I am extremely happy to be working with Practical Action, to be helping my community to prepare for floods. For me, it is like a mother helping her new born child – caring and looking after it. It is all about saving lives – there is nothing more important than that.***
>
> – Nirmala Pokharel, Parsauni, Nawalparasi

Early Days

In 2002 Practical Action carried out a pilot project, erecting an observation tower and siren system in Bhandara, Chitwan. The project was implemented to assess the potential and opportunity for purely local level observation and warning of flood with its objectives set very much within the operational and security environment prevalent in 2002. Specifically that government institutions were finding it increasingly difficult to operate in many rural locations, while the deteriorating security environment made it imperative that whatever systems were established they be community managed and independent of outside support.

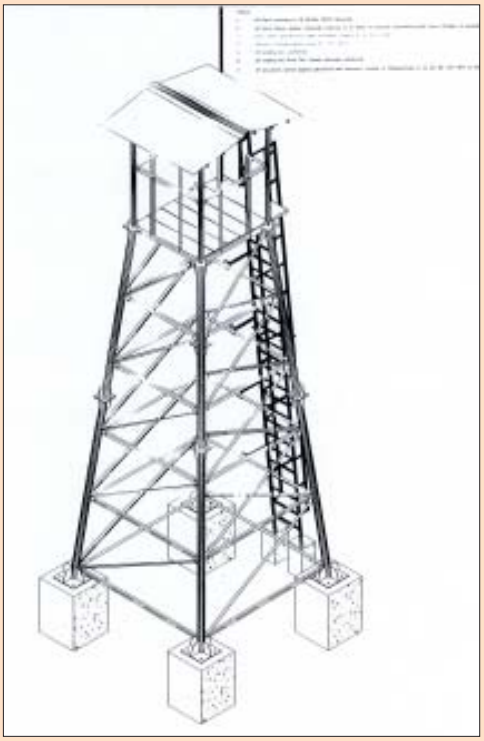
Construction of the tower and provision of siren systems were managed by Practical Action while site identification, land purchase, community mobilisation, awareness raising and establishing a user committee were the responsibility of the community.

"The tower can be of great use in alerting people to flood. There would not have been such big casualties and losses in the flood of 1993 if there had been an early warning system then."

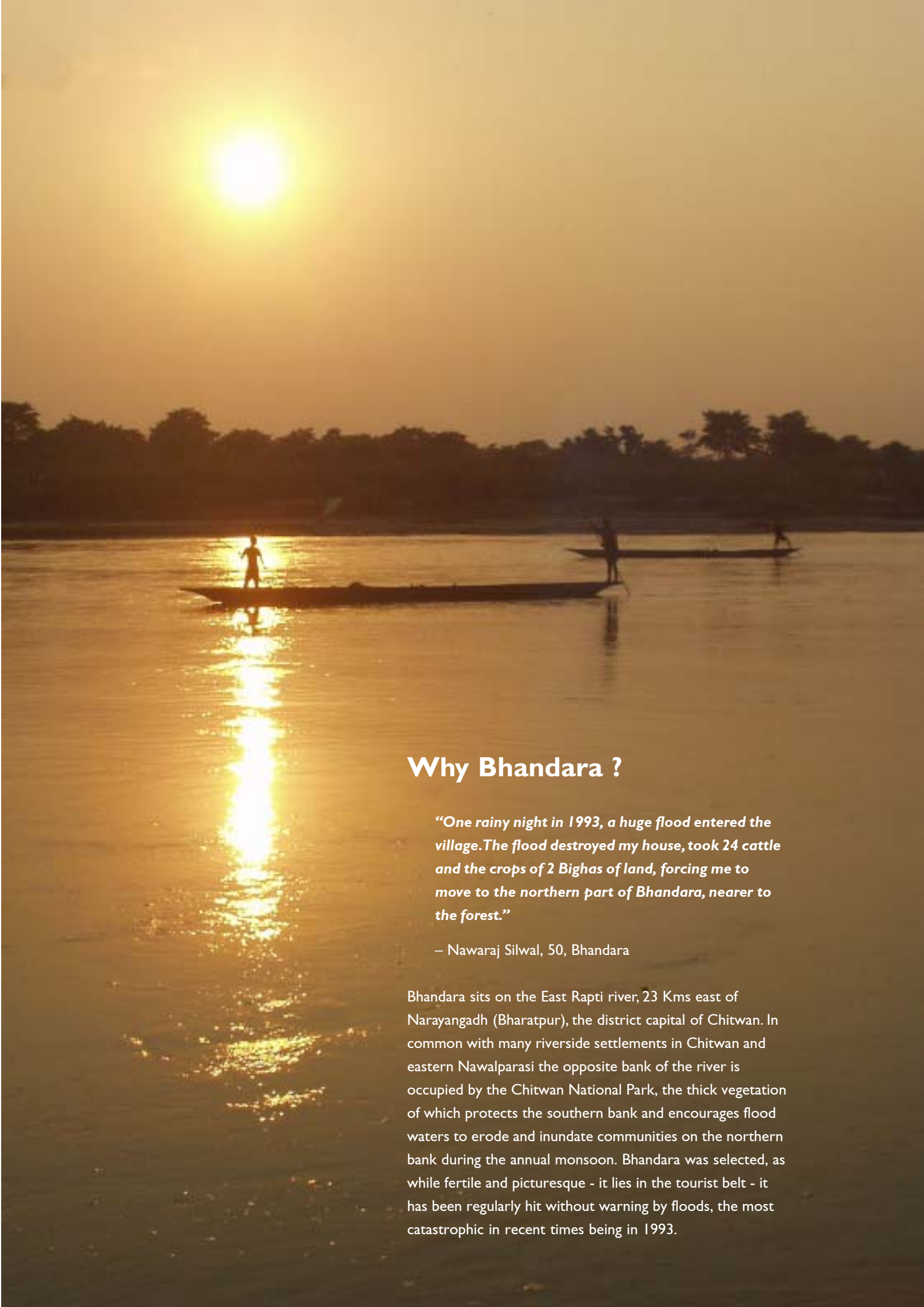
– Sabitra Pandey, Bhandara.

System design

Due to the lack of reliable mains electricity supply a locally available siren, which could run off a 12 volt (i.e. car) battery was selected. With nominal 1.5 Kms range this proved satisfactory in testing but under real-life conditions (i.e. periods of torrential rain falling primarily on metal, sheet roofs) actual range was found to be far less. Similarly power draw on the batteries provided was higher than stated, requiring regular recharging. While the system and the extent of the warning was never meant to depend on the range of the siren alone, it was realised that in establishing future systems greater range would have to be sort. It was also found that while the siren itself performed reliably, associated battery and switch systems proved less robust, with resultant sustainability questions having to be asked.



Tower construction was carried out through commercial tender, partly as this was a new technical area for Practical Action, but primarily due to time constraints and donor requirements. While the tower has proved satisfactory in operation its method of construction provided valuable learning as it was realised incorporation of locally priortised features in to the design and community labour into the construction would greatly increase long term ownership.



Why Bhandara ?

"One rainy night in 1993, a huge flood entered the village. The flood destroyed my house, took 24 cattle and the crops of 2 Bighas of land, forcing me to move to the northern part of Bhandara, nearer to the forest."

– Nawaraj Silwal, 50, Bhandara

Bhandara sits on the East Rapti river, 23 Kms east of Narayangadh (Bharatpur), the district capital of Chitwan. In common with many riverside settlements in Chitwan and eastern Nawalparasi the opposite bank of the river is occupied by the Chitwan National Park, the thick vegetation of which protects the southern bank and encourages flood waters to erode and inundate communities on the northern bank during the annual monsoon. Bhandara was selected, as while fertile and picturesque - it lies in the tourist belt - it has been regularly hit without warning by floods, the most catastrophic in recent times being in 1993.

Though a single 'stand alone' project experience gained through its implementation and follow up visits which have continued ever since have generated valuable learning.

Strengths

- Greater peace of mind was created within the community through the knowledge that someone was watching the river, 24hrs a day.
- Providing something tangible acted as a spur and catalyst for other activities in the community, the tower having a strong psychological impact.
- Alternative income generating activities, primarily bird and animal viewing, were unanticipated spin-offs (the tower overlooking the Chitwan National Park).

Weaknesses

- Insufficient attention to community sensitisation and mobilisation reduced awareness and participation.
- Too much focus on a 'quick fix' technical solution, when it became apparent software components were as, if not more, important.
- Difficulties in managing expectations in regards to what the system could actually achieve.
- Siren components were inappropriate for the job, neither having the simplicity of manual systems, nor the reach or capacity of 220/240 volt systems.
- An insufficiently participatory approach to tower design.
- Lack of awareness and training information in local languages.
- The inability to link to external support structures or information sources.

Conclusions

- Having something visual, or somewhere specifically designated from where observations and warnings can be made, is a real plus.
- The technical elements of a warning systems have to be self contained if reliant on electricity, as well as highly robust.
- Communities have to be made aware that systems are reliant on their own motivation and organisation, as technical elements can only complement these human components.
- Committees or individuals responsible for system management must be truly representative.
- The concept of early warning being new, it is best introduced as part of a more general DRR project, particularly one providing more immediate tangible benefits.

Chitwan and Nawalparasi

In expanding its programme Practical Action chose to remain in the same geographical area extending downstream, west, to the communities of Piple, Jagatpur and Meghauli on the Rapti river in Chitwan, and then on into Pithauli, Kolhuwa and Parsauni on the Narayani river, in Nawalparasi. Within these communities approximately 34,500 individuals now benefit from the setting up of the EWS and other project activities, with the latter including the distribution of 70 life jackets and other life saving equipment, construction of 15 boats, 6 bridges, 9 spurs and dykes, and 6 shelters, as well as a broad range of public awareness and education activities including poster and leaflet distributions, FM broadcasts, street theatre, song and dance competitions and schools activities.

Chitwan and Nawalparasi are among the most flood prone districts in Nepal, appearing high on the lists of loss and damage each year.

"Watch and Warn"

Community level observation

Practical Action's next step was to build on the learning of its pilot project, address its short comings, and increase the impact and coverage of future systems.

As the launching of an EWS programme in isolation was unlikely to generate much enthusiasm, it was decided it would be incorporated within a wider CBDM programme, containing elements of more immediate benefit to communities. As such the EWS would be only one component, albeit a critical one, of a broader risk reduction programme.

The concept of early warning being new, it was constantly raised during other activities, to generate discussion and familiarity, and to ensure communities were actively engaged in its formulation. In these discussions, a number of key issues were stressed;

- Any technology Practical Action introduced was not going to provide early warning in itself. It would merely assist the spreading of early warning within communities, by the communities themselves.
- "Triggers" for early warning would be human, not mechanical, it being up to communities to decide what these triggers might be - as the circumstances in each community differed.
- Early warning systems were useless without general and widespread understanding and the establishment of appropriate response mechanisms.

It was critical that the concept of self reliance be accepted, as at this point there was no indication of any district government support, nor assistance from national level institutions, such as the DH&M. As such it was asked what communities felt could be achieved through local observation and warning alone, with the following observations being common to all locations:

- To date there was no formal system of watching taking place, so many people were watching the river at the same time during periods of high water.
- Due to the prevalent rainfall patterns floods tended to come at night. This meant people had to keep watch especially, rather than as part of their routine activities.
- Many houses and locations at risk to flood had no clear view of the river making frequent visits necessary during periods of high water.
- Water ingress was not observable in many places, due to the lie of the land and dense vegetation during the monsoon period. This meant flood waters often entered houses before people were even aware that there was a threat, making it impossible to save anything but the most important things.
- Many people lost sleep during the high water periods, due to stress and worry.

From this communities agreed that;

- Formal "watch and warn" rotas would be set-up, or full time watchmen paid during the critical flood periods, to watch on behalf of everyone.
- Sites would be identified giving the best view of both the river and community, given that water often flowed into villages from directions other than the nearest river bank.
- Some form of warning, which everyone could understand, should be established.

As such Practical Action agreed to design, source, fund and manage the construction of watch towers where communities could identify appropriate observation sites and contribute labour. This was based upon the strong psychological impact the tower had had in Practical Action's previous project and as a result of community visits to the Bhandara site, which generated much enthusiasm. Towers were erected in 5 out of the 6 communities targeted, incorporating design improvements influenced both by learning from Bhandara and ideas generated within the new project area.

Experience suggested reliance on mains electricity was unwise, so alternative sources of warning were discussed. Study revealed no existing 'indigenous' warning systems - which was not unexpected given that most communities were made up of migrants and flood was a recent phenomena - nor that any locally manufactured hand sirens or warning systems were available. As such it was agreed to opt for 'stand alone' electrical siren systems again, communities having witnessed these in Bhandara previously.

By the monsoon of 2007 systems were completed in all five locations. The "watch" component was managed differently in each community, but a common warning system was agreed throughout the area, as a result of an inter-community exchange programme. The first sounding of a siren indicated that communities should prepare, while a second one meant that they should evacuate. As sirens only transmitted so far, communities established relay systems, reliant on volunteers going door to door, to pass on warnings received. Evacuation in all locations was further assisted by other components of the programme such as the improvement of bridges and provision of boats.

Strengths

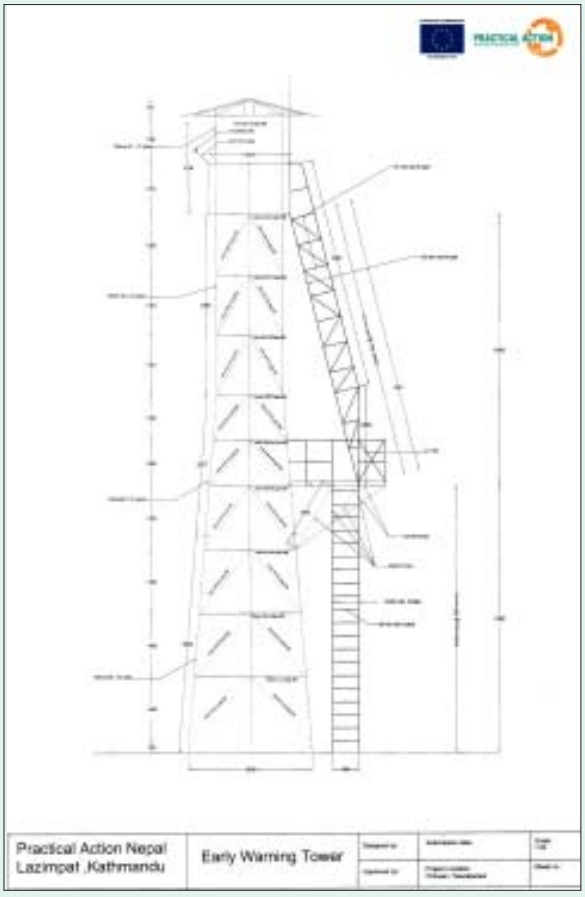
- Genuine intra-community warning systems were established to which the siren was only a trigger.
- There is now additional time for people to gather family members, valuable assets, live stock and stored food.
- The system has proved robust when external sources of information have failed.
- Communities have felt empowered and increasingly secure.
- There is now less fatalism about floods and the inevitability of the destruction that they bring.

Weaknesses

- Sirens, no matter how powerful, have limited range.
- It's been found that any warning will trigger an evacuation.
- Only limited extra warning time is given, of an hour or two maximum, when more would be ideal.
- The system has low short term maintenance, but high long term replacement costs, particularly of siren system components.

System components

Towers constructed incorporated improvements over the pilot model including better weather protection, safer ladders, tamper free construction methods and fool-proof electrical component connections. Critically they were built entirely using local labour, which ensured increased community ownership and a commitment to long term maintenance and repair.



With the aim of increasing siren range a 220/240 volt system was decided upon. This required the use of inverters and greatly increased battery capacity compared to the Bhandara system, with a users manual being developed in tandem with training given to community volunteers.

In use whilst siren range was found to be increased it was not easy to justify the increased system complication and cost (and hence reduced sustainability) when compared to that established during the trial phase. This became a major influence on future system decisions.

7th September 2007 "Real time evaluation"

"As soon as we heard the sound of the siren, we came out of our house, we took our cattle to a nearby highland area, called Thule Chour, and shifted our valuables from the ground floor to the upper floor of the house."
– Basanta Chaudhari, a resident of Bagaincha tole

On 7th September 2007 local FM radio stations reported the displacement of many people from riverside communities within Nawalparasi. To assess the situation first hand Practical Actions Project Officer,Anup Phaiju, visited Laugai in Pithauli and found that the occupants of seven houses had moved to safer ground between 7.00 and 11.00 am on the 6th of September. Additionally Nur Bahardur Shrestha and Kancha Gurung, community volunteers, had used boats provided by the project to evacuate another 40 people.

"Now that we know when the floods are coming, my family doesn't have to take shelter on the roof anymore! We have enough time to collect out valuables and use the bridge to reach a safer place."
– Mangali Kumal

Gairi, a community nearby, was also visited where familiar faces were met, including members of the PIC (Project Implementation Committee). They had actually sounded their siren for the first time at 8:30 pm the previous evening, following a sponteneous bank-side meeting. After assessing the situation it had been collectively decided the threat was sufficiently high to warrant a warning and as such the siren had been sounded as darkness fell.

"It wasn't in our minds that the sound from the siren could also be the sound for help, so we were astounded when we saw the people gathered."
– Hom Bahadur Gurung

The community reacted promptly, relaying the warning house to house with many people moving

along with their goods and livestock. Interestingly, while it was communicated previously during a door-to-door campaign that people only needed to leave their homes after the second sounding in reality very few decided to wait ! Also, surprisingly, many people from safe, upland areas, on hearing the siren came to help those evacuating, offering accommodation and assistance.

"We are surprised that the people from the upland area came to help the flood victims."
- Kum Bahadur Gurung (PIC Chairperson)

A critical piece of information gained at this point was that while the community in Pithauli had tried to warn their down stream counter parts, in Kolhuwa, Narayani and Prasauni, it had proved impossible. The washing away of a 40 metre section of the main east west highway had severed optical fibres, rendering telephone networks useless and leaving communities entirely isolated from outside support. This tended to support some of the assumptions underpinning Practical Action's original decisions on the form that the EWS should take, namely that systems should not rely on outside sources of information or warning unless these could be guaranteed in regards to accuracy (of information) and reliability (technically) of supply.

"We community people must work together to help ourselves. Just like now it will always be possible that external help might not come as the telephones might fail again."
- Bhagawati Gautam

This experience greatly influenced Practical Action's next stage of EWS development.

It was clear that if information was to be reliably supplied over long distance, very robust communication systems and/or multiple channels of communication would be required to avoid similar failures.

River Basin Systems

"If we can make early warning effective and efficient, the necessity for rescue can be reduced – if we can manage better with what we have I don't think we need 'big' technologies, we don't need more resources and we don't need extra personnel."

– Narendra Raj Sharma, CDO, Banke

In early 2007 Practical Action researched other areas which could benefit from the establishment of EWS. During 2005 and 2006 Banke and Bardia districts of Mid-Western Nepal had suffered disproportionately, both in terms of loss of life and assets, and as such were prioritised as targets.

The systems established could afford and ultimately required a more ambitious approach to early warning than had been attempted previously however, as at the higher level district government buy-in was now anticipated, though in no way taken for granted, as was the support of the DH&M, with whom Practical Action was in dialogue. Similarly at the 'last mile' stage greater understanding of the abilities and capacities of communities to manage systems lead Practical Action to aim for bolder targets in terms of coverage and reach.

The communities Practical Action targeted in each district had similar profiles so, as previously, the approach was to promote a broad, community based DRR programme in each location. To kick start the EWS component both community members and partner organisation staff from Chitwan and Nawalaparasi visited the new sites to share their own experiences of EWS and what was being achieved in their own communities.

These activities not only 'fast tracked' communities and partners alike, but helped to encourage the development of an informal national early warning users network, a long term ambition of Practical Action.

Communities on the West Rapti and Babai rivers

Practical Action, and its partners CSDR and RKJS, targeted the historically most flood prone communities in Banke and Bardia, selecting Holiya, Betahani and Phatepur on the West Rapti river in Banke, and Mohamadpur and selected Wards of Gulariya municipality on the Babai river in Bardia. These communities all have similarities being;

- At the extreme downstream (India border) reaches of major river systems.
- On river systems where flow levels are influenced by rainfall far upstream.
- In areas where floods have been occurring more regularly in recent years.
- In areas where evacuation in case of flood might take many hours.
- Recipients of relief assistance during times of flood but lacking any long term developmental inputs.
- In areas of high poverty, low income and low private land ownership.
- Socially, religiously and ethnically diverse.

In total over 86,000 people now benefit directly from the two river system based EWS established.

Factors likely to influence the nature of the EWS were discussed widely, with key considerations arising including;

- Limited, intermittent or absent mains electricity supply.
- Poor telephone connectivity.
- Low levels of private telephone ownership.
- Poor inter and intra community infrastructure and roads (though some were being improved as part of the programme).
- Limited technical skills within communities to manage complicated systems hardware.
- River levels dependent on upstream rainfall patterns, so beyond local community's abilities to monitor or manage through local observation.
- Poor links with, and some distrust of, government and emergency service institutions.
- Limited indigenous knowledge or skills on which to draw in relation to flood and early warning.
- Relatively high levels of FM radio ownership.

These led to the following decisions

1. That powered warning systems at the community level were simply not viable, either technically or financially, if reliability and sustainability were to be ensured.
2. That information from upstream locations was required if genuine early warning was to be provided.
3. That genuinely representative committees and volunteer groups had to be created if comprehensive coverage was to be achieved in linguistically, religiously and ethnically diverse communities.

Making sense of it all

The issue of making information "accessible", in real terms, called for simple leg work, setting up meetings between DH&M staff and community members, and very basic calculations.

The first stage was to gather DH&M river level records from stations on the Babai and West Rapti for 2006 and 2007, as these were both years of flood, and recent enough in people's memories for them to be able to remember specific dates and events. By asking communities to identify the date on which rivers broke their banks in these years it was possible to identify the level at gauging stations on the same days, these pieces of information being the first historical 'benchmarks'.

When discussing these levels with community members in Holiya (Banke), we were surprised to find that one community member, Ram Kumar Bahun, had detailed records giving clear measurements during the previous monsoon periods. Discovering and using such sources of local knowledge greatly cut down the research and analysis needed and, critically, ensured community members were at the heart of the whole process of demystifying the official records.

Studying records maintained by Ram Kumar Bahun (second left) in Holiya, Banke.

Similarly by identifying the highest readings recorded at gauging stations it was easy for communities to identify the dates and levels recorded within their own communities, people normally remembering these as specific levels on houses, trees or other bits of community infrastructure.

As an example community members from Balapur in Ward 6 of Gulariya pinpointed 11 Bhadra 2063 (27th August) as the day floods hit their village in 2006, with the waters first entering at 6.00 am, reaching a peak at 10.00 am and receding again by 6.00 pm (interestingly all time calculations were based on discussions as to how long

4. That what ever systems were established they had to link with district level emergency service bodies and existing disaster response mechanisms.

To achieve these requirements and meet ambitious targets for the programme a three pronged approach was decided upon. This targeted district level "buy-in", community level capacity building, and the gaining of institutional support. To achieve these an approach based on consultation, discussion and mass participation was taken, starting with the holding of a range of stakeholder meetings and dialogues, some specialised others mixed, which have continued throughout the programme.

Seeking Institutional Support

As local observation could not give sufficient warning communities required the supply of information from far upstream. It was known the DH&M had existing monitoring stations so a series of visits took place to facilities on the Babai (Bardia) and West Rapti (Banke) rivers. These visits included district government and DH&M staff, community members, police and military personnel and representatives of the Red Cross and media.

Through inspection of resources, review of records and discussion with the local DH&M "gauge readers" on site, the existing capacity to provide information very quickly became apparent and very active discussion, both in situ and in the local media subsequently took place.

after 'cock-crow' certain events took place, rather than specific times, due to limited access to watches/clocks, particularly among women).

When discussing conditions in 2007, community members, in both districts, identified 10th Shrawan 2064 (26th July) as the critical day. In Balapur the water first entered the village at 8.00 am, reached its peak at 12.00 noon, stayed constant for a further 3 hours and by 7.00 pm had receded one foot from its high water level.

On the same day on the Rapti River the station at Kusum recorded a level of 5.65 Metres, the highest level recorded that year.

PIC (Project Implementation Committee) Vice-Chairperson Mr. Tihar Bahadur Tharu (right), of ward 6 Gulariya, indicating the 2006 high water level (the 2007 level is the white mark 50cm below).

From this analysis (comparing gauge station figures with community flood histories) it was relatively easy to calculate;

1. The upstream river level at which down stream inundation is first likely to occur (for each community).
2. The speed of flow between the gauge station and the community during peak flood periods.

Given these two basic sets of data rough extrapolations could be made for all upstream river levels i.e. what these levels would mean in terms of flood for down stream communities (when the flood would occur and how high it would reach).

It should be noted that while Practical Action had access to sophisticated computer modeling options to carry out this work this approach was rejected as

1. there was no justification for resorting to 'theoretical' approaches when "real" data existed, and
2. it would have taken the process of data analysis out of the hands of the communities and given it to "experts", thus undermining the whole objective of demystify the information and empowering the communities. It would also have precluded the making of personal connections between the local DH&M staff and community members so critical to the systems long term sustainability.

What became apparent from these visits was that;

- Comprehensive records existed for river levels, recorded three times a day, but that these were gathered largely for long term planning and historical purposes only.
- Real time transmission took place once a day, but only to Kathmandu and India, with no onward dissemination beyond.
- No extrapolation of data had been carried out to date, so no understanding existed of what a given river level in an upstream monitoring location might mean for communities down stream.
- Technical difficulties or equipment deficiencies existed in some monitoring sites making more regular or reliable communication difficult.
- Enthusiasm and willingness existed on the part of gauge readers to contribute to the proposed EWS.

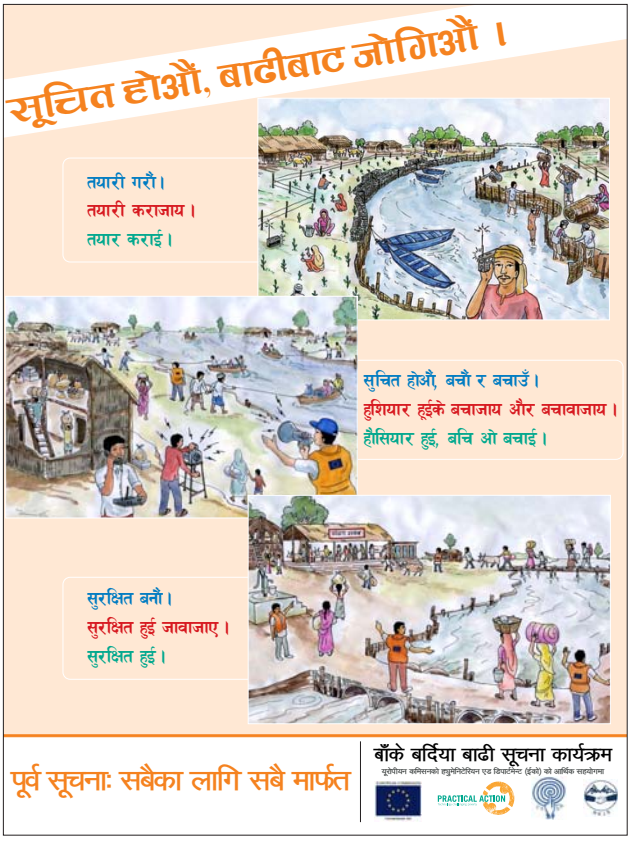
Following the visits talks took place with staff of the DH&M during meetings at the district level, which agreed the following actions;

- DH&M would make available all historical and 'real time' information as outlined by district stakeholders as useful for the purposes of early warning.
- Practical Action could pay for additional monitoring of river levels, beyond the present three times a day, during the monsoon, if these costs were covered by the DH&M or district authorities in future years.
- Practical Action would work with local DH&M staff and community members to turn raw river level data into meaningful warning information based on the historical memories of flood existing within communities.
- Practical Action would provided CDMA (cost effective satelite telephones) for gauge stations were these did not exist already, plus credit for the monsoon period, if recurrent cost would be covered by the DH&M or district authorities in future years.
- District authorities would coordinate the gathering of lists of prioritised telephone numbers and locations to contact in times of risk. These would be supplied to gauge reading staff and all other contacts in the communication system.
- FM radio stations would broadcast information as supplied by DH&M staff.

Seeking district level "buy-in"

At the district level, the target was to demonstrate that investing in EWS was worthwhile (in comparison to investment in post-disaster response for example), that EWS

District stakeholders and media representatives discussing DH&M facilities at the Bahalubang meteorological station on the West Rapti river.

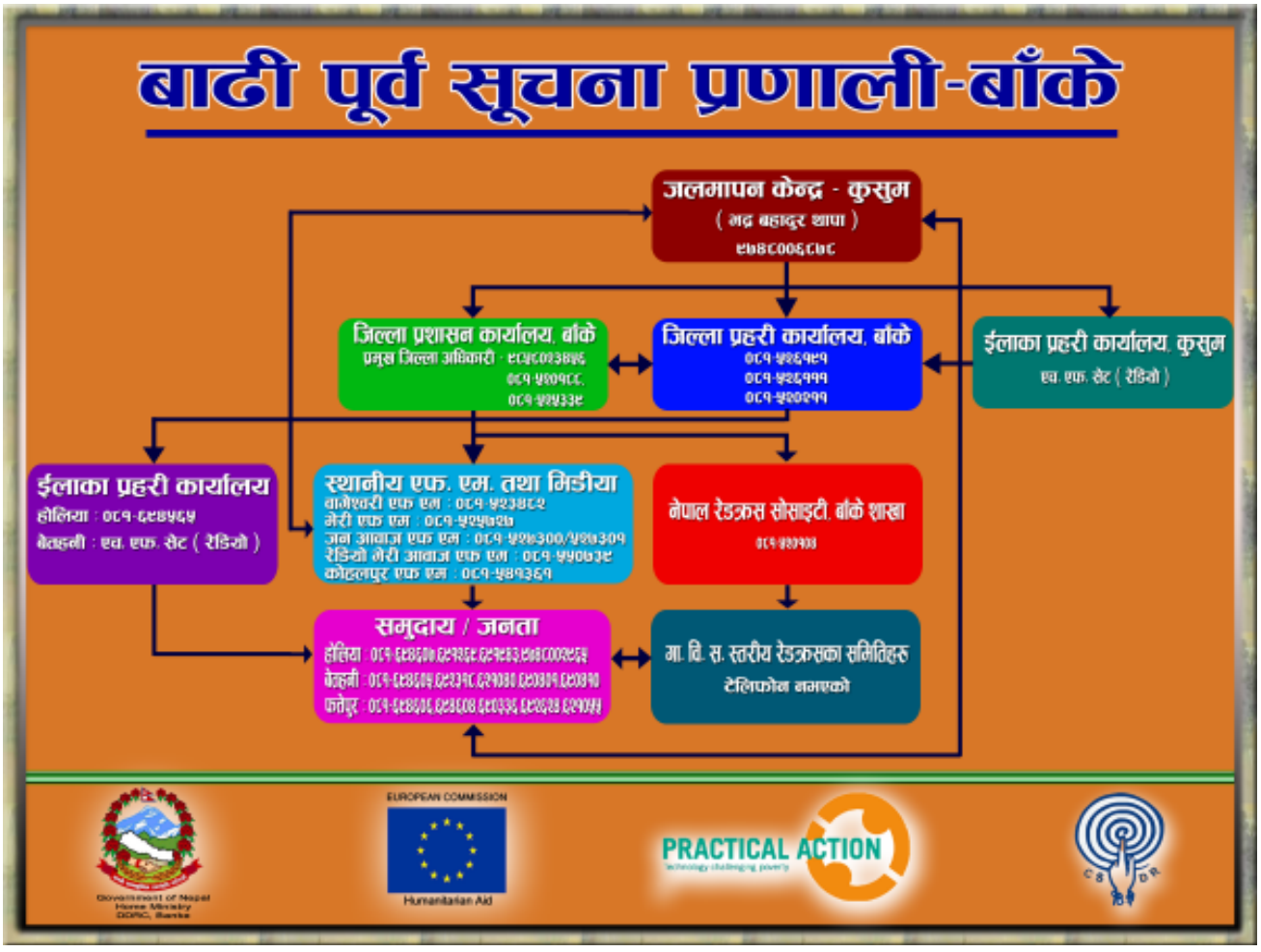


Poster in three languages

were technically feasible, financially sustainable and would not create unmanagable increases in workload. It was also critical that district authorities be convinced that these were 'their' systems, as without official adoption there was little hope of long term sustainability.

Initial exposure visits arguably achieved the first three objective in one go, as it became clear that information sources and all the information required already existed (albeit in "raw" form), that communication systems could certainly be established, and that the costs of obtaining the information and improving the communication hardware necessary would be minimal.

In terms of workload and management input further discussions were required to jointly develop the communication channels and system responsibilities. In this Practical Action was confident similarly positive outcomes would be achieved, as while a downward "supply" structure and approach were initially discussed at district level, discussions at community level were already indicating a more direct "demand" system would actually develop.



Communication diagram for Banke District giving key contact telephone numbers and names.

Community mobilisation

At the field level public awareness activities had a greater EWS focus than in previous projects and open discussion of the opportunities and potentials for EWS in the area took place from the outset. In looking at ways warning could be disseminated at the "last mile" level the use of hand sirens was eventually decided upon.

Pulling it all together

A number of meetings were held between January and July 2008 to discuss the development of the system, the information channels required and the 'warning' to be communicated.

These on-going discussions soon revealed that no "warning" as such would be necessary. It was clear that communities, having been involved in all exposure visits and system discussions, were perfectly capable of interpreting river level data if provided and could decide on the 'trigger' mechanisms for warnings at community level themselves. Ultimately this would have been necessary under any system anyway, as each community has different levels of risk and exposure to flood, not all being threatened equally. As such it was agreed that all communities needed to receive was the river level information from the upstream DH&M stations.

Warning choices

In looking at options to spread warning in Banke and Bardia it was decided to take a different approach to minimising coverage. Instead of minimising the range of single warning systems, as in Chitwan and Nawalparasi, it was decided to increase the number of warning sites themselves, and thus increase coverage in that way.

In a similar vein, and given that reliable electrical power supply could not be guaranteed, non-electrical powered options were explored, these being both more robust and reliable, cheaper and ultimately more sustainable. Previous research and advertising had failed to locate

suppliers in Nepal and as such these were sourced in India, with two possible options being identified. Quoted specifications were similar so models of both were ordered for testing. Both consisted of a hand powered single tone siren, with a quoted range of 1km. Other options were looked into, but no hand powered devise with a range equaling these systems could be identified.

Samples of the two types were circulated extensively throughout the project areas so that community members

In terms of communication channels, all stakeholders were aware of the difficulties which arise during the monsoon. Landlines regularly get cut (as experienced previously in Nawalparasi), cell phone networks crash, and individual mobiles become inoperative due to more general electric failures.

As such for the gauge reader staff landline/cell phone links were prioritsed in the first instance, for cost reasons, with CDMA as the back-up. In case of all these failing HF stations operated by the police existed as additional back-up, police stations being in close proximity to all DH&M facilites. As a further back-up commitment was made by the military base close to the Chepang station to provide a further HF communication option on the Babai.

At the community level a comprehensive survey exercise took place, geographically mapping all landline, mobile and CDMA locations, as well as FM radio ownership. Communities then prioritsed the numbers to be called in the case of warning, ensuring a good geographic spread throughout the communities (some being quite large). Where major 'gaps' existed Practical Action provided CDMA 'phones at community level also, though it was agreed any running costs for these would be borne by the community themselves, their purpose being to receive calls, not make them.

At the central, district level, a similar exercise took place, with a comprehensive list of 24hr hour contact details being

could familiarise themselves with them, test the options side by side, and discuss their suitability and possible shortcomings. Tests were carried out in both formal and informal settings, with it being ensured that all major stakeholders took part in a test in at least one location. As such representatives from the military, police, Red Cross, etc, all participated.

In experimentation, communities were asked for suggestions as to their most effective use, this being an important process in putting communities firmly to the fore in system set-up decision making.

43 sirens, of the type selected by end users, have now been distributed, with communities in each location deciding on how they should be dispersed and managed, and how warnings should be relayed to individuals and settlements beyond the range of the sirens.

During the testing community members from Practical Action's previous project sites in Chitwan and Nawlaparasi, who were visiting to assist new project committees establish themselves, also took part. They were so impressed by the hand sirens that it was agreed to retro-supply these to the existing sites.

The cost of sustainability ?

It is estimated that the entire recurrent costs for 2009, per watershed warning system, will be less than 20,000 rupees (£157 / €227 / $249).

In 2008 the cost of additional river level monitoring, above that already paid for by the DH&M, was 12,000 rupees (£95 / €137 / $150) per river system, with telephone charges being an additional 5,000 rupees (£39 / €59 / $62) per river. Telephone charges were lower than anticipated as the "demand" nature of the system meant that after issuing initial warnings gauge readers simply had to field requests for information, rather than proactively disseminating it themselves.

Beyond these costs the only hardware "set-up" costs were 79,900 rupees (£629 / €908 / $997) spent on 10 CDMA telephones (5 for communities in Bardia, 4 in Banke, and one for the gauge reader at Chepang on the Babai river). In other locations, with better telephone connectivity, these cost might be avoided entirely. FM stations, while requesting funding initially now realise broadcast of river levels is a public service priority and as such are no longer charging.

> ***"Last year we broadcast how many people had died or were missing. This year we could broadcast the warning that flood is coming."***
> – Lil Prakash Chand news coordinator of Bageswori FM

Beyond this the hosting of an annual pre-monsoon meeting, which occurs in most districts anyway, would be all that would be required to 'refresh' the system and update and test communication channels.

With set-up and running costs such as these surely it is hard to argue against investment ?

gathered for district level stake holders. These included key District Authority staff, police, armed police, army, Red Cross and, critically, FM radio stations.

Once these channels and numbers had been agreed upon, system 'maps' were printed and distributed to all stakeholders, for location next to telephones and radios incorporated in to the system.

These systems and plans were shared extensively, not least during the annual "pre-monsoon" meetings, which are held in every district administration in May or June.

Real Life Testing: The system in action

On 27th and 28th June 2008 rainfall had been extreme in Kapilbastu and Dang with river levels on the West Rapti in Banke rising alarmingly. At 7.30 am on 28th the level reached 4.5 Meters at Kusum, the "trigger" level above which community records indicated floods could be expected in downstream settlements.

Bhadra Bahadur Thapa, the DH&M gauge reader at Kusum, who had been checking the level regularly from early morning, first telephoned Radheshyam Sunar, a PIC member from Holiya, who responded by saying that he would pass the message on locally to other community members. Following this the message was passed on to Sabitram Barma, also of Holiya, who took it upon himself to inform other community members, starting the relay system.

At 7.38 am, Bhadra informed the district Police office in Banke, with the sub-inspector on duty understanding the importance of the information and assuring him he would pass it on to the District Administration Office and outlying police posts within the communities themselves.

By 7.40 am, Tara Thapa, PIC Chair in Phattepur, was also informed, followed by Bageshwori FM, the main radio station in Nepalgunj. They noted the flood measurements and committed to broadcast them during the next bulletin.

At 7.50 am, Mr. Bhadra contacted Bhagauti Psd Barma, of Betahani, who was reported to be very excited on receiving the warning. "***You are our savior***" he said, as conditions around Betahani gave no indication of impending flood at this point - the reason being that much of the settled area of Betahani is well back from the banks of the Rapti, and actually on a tributary called the Duduwa. This river was still low at the time of warning and as such they thought, incorrectly, that they had nothing to fear. Mr. Barma asked that they be continuously informed of any further river level increases.

Finally, just before 8.00 am, Bhadra called Narendra Raj Sharma, the CDO (Chief District Officer) of Banke, and similarly informed him of the situation. The CDO thanked him for his work and asked him to continue informing the community and media.

Interestingly however, from this point on, there was no need to inform others as many people were now contacting the gauge reader at Kusum direct, both from within the vulnerable communities and the emergency services.

Mr. J. Pande, a Nepalganj based journalist, after hearing the news on Bageshwori FM at 10 am, repeatedly called Bhadra Bahadur for updates and water levels, calling 6 or 7 times (i.e. nearly once an hour), as the gauge reader reported his last call around 7.00 pm, when the message was "***the maximum water level was 5.0 Meters at 6.50 pm, and it is now gradually going down***".

Similarly Mr. Iswori Regmi, on behalf of the Banke chapter of the Nepal Red Cross Society, having become aware of the situation, stayed in constant contact, as did offices of the police and Santosh Regmi, of Radio Nepal, among the many media contacts.

Community response

In Holiya and Betahani, while river levels grew dangerously high throughout the day the banks were never breached. Thus while the situation was monitored intently, no siren warnings were issued. In Phattapur however the situation was far more serious.

The chair of the PIC and other PIC members received information of the river level early in the day and started monitoring the level at the river side from 10.40 am onwards. The water continuously rose and at 5.00 pm it started to inundate the areas known as Joraiya, Khalla Tepari, Sidhanawa and Bishambharpur (Phattepur being very large, nearly 20 Kms north to south).

With it getting late, water levels still rising, and with a history of high water levels and floods occurring during the night, in consultation with Tara Thapa, Bishnu Adhikari, Maghu Chaudhari (PIC Members) and Krishna Chaudhari and Guru Chaudhari (community volunteers) at 5.30 pm it was decided to sound the hand sirens in an hour if there was no improvement.

At 6.30 pm sirens were sounded in the main centers of population and the process started of relaying the information throughout the area.

Many farmers in Joraiya, Khalla Tepari, Gulaldeva, Bisambharpur and Sidhanawa, on hearing the warning, started taking their ploughs, oxen and agricultural tools to higher land. Traditionally farmers here leave their tools and oxen near their farm land, as it can be distant from their homes, but as in past years, when there was no warning, they had often been lost, they moved them in advance this time.

Fishermen, such as Balak Godia, Bahur Godia and their friends, were fishing on the Rapti on 28th June. On hearing the sound of the siren from the Joraiya area about 6.45 pm, they realised the threat and returned quickly to the river bank, stating if they had not heard the siren they might have remained fishing 'till midnight, possibly camping on one of the many islands in the river. If they had it could have been disasterous.

In the event, on 28th June, the waters rose no more. As reported by Bhadra Bahadur, at Kusum at 6.50 pm, they had reached their peak and were now subsiding. The 'test' however indicated a good decision making and dissemination system had been set in place and would guarantee wide-scale warning in the case of a genuine flood.

Perhaps the greatest success of this "real time test" however was that throughout, community members were ***actively gathering information*** as opposed to ***passively* receiving *warnings***, which was always the ambition of the system.

The Future

During 2008 real life tests of the system took place on the Babai river in Bardia on 15th June, 27th August and 20th September. On the West Rapti in Banke they occurred on the 28th June and 21st September. Previously "Mock Drills" had also been held in each location, just in case such real life testing had not occurred. In each case the system worked as planned, with the initial supply of raw river level information being sufficient to trigger community mobilisation, observation and discussion, leading to collective decision making over how and when to make "official" warnings through use of the sirens.

Critically while Practical Action and its partners RKJS and CSDR were included in the communication channels during initial warnings, by September 2008 the system had largely dispensed with the need for their involvement. Links and mutual understanding had been created between community members and DH&M staff in both districts, with the communication channels established linking these to existing district level government and emergency service systems and local radio stations.

Practical Action and its partners CSDR, RKJS, SAHAMATI and CSC believe their activities in piloting EWS in Nepal have highlighted the applicability, cost effectiveness, utility and critically, the replicability of the systems trialed to date.

In areas where communication difficulties, lack of upstream information sources or the nature of flood preclude long distance warning (as in the case of flash flood) community based "Watch and Warn" activities can play an important role in reducing people's vulnerabilities. In the right circumstances even a few minutes warning can allow for the moving of livestock or seeds, household necessities or farm implements, the loss of which might otherwise set back a household or community for years. The role EWS can play in livelihood protection can not be overstated.

On more major river systems, where flow times can be great and where monitoring infrastructure and staff already exist, Practical Action's programme has demonstrated that warning of many hours duration can be achieved through minimal investment. In much of flood prone Nepal Practical Action is convinced this is where and how investment should be made. EWS can benefit those most at risk.

In establishing systems however the principal of "end user first" is critical, with users being at the core of the system, not beneficiaries of it. As such, in setting up EWS Practical Action strongly recommends the following considerations be incorporated.

- Integrate EWS within the framework of broader DRR activities, as to try to establish them in isolation is unlikely to result in success.
- Systems must prioritise software components, public awareness activities and demystifying early warning. There are no shortcuts or technical quick fixes if sustainability is to be achieved.
- Systems must supply information, not warning per se, and communities must be involved in the interpretation of information and encouraged to actively engage with information providers.
- Popular media, primarily FM radio, must be encouraged to act in a public service capacity as a key 'amplifier' of information supplied.
- Systems must be set up on an information "demand" model, not one of "supply".
- Communication and warning "technology" should only be added to the "mix" at the final stages of system set-up.
- Use existing resources, structures, information sources and technologies where ever they exist.

Project CD This CD contains an electronic version of the text contained in this book in both PDF and Text formats. The documents are provided so users can edit and use elements of the text as they require. Practical Action actively encourages such use and asks simply that the source of the original be acknowledged in any use.

The CD also contains over 70 pages of "Set-up Notes" on which the text of the River Basin Systems section is based, design documents for EWS towers established in Chitwan and Nawalparasi, PDF files of awareness materials used during the projects and other background material.

Project DVD This 30 minute film covers the various stages in the setting up and functioning of all systems highlighted in this book. It is intended as a briefing and training resource and is available for transmission in any forum without the prior approval of Practical Action or the European Commission though credit should be given.

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The commitment of communities in Bhandara, Piple, Jagatpur and Meghauli in Chitwan; Pithauli, Kolhuwa and Parsauni in Nawalparasi; Holiya, Betanhai and Phatapur in Banke; and Gulariya and Mohamadpur in Bardia made these projects the success they have been. Without their enthusiasm, motivation and willingness to consider new approaches, very little would have been achieved. We hope "their" early warning systems will give them greater security in the future and lead to safer, risk free, lives.

SAHAMATI, CSC, RKJS and CSDR were Practical Action's partners in the field and their role and importance can not be overstated. It is to our regret that we have not been able to give them greater credit within the limited space available in this publication. Practical Action never had more than two staff working on its EWS programmes between 2002 and 2008, working entirely through its partners at field level.

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