An overview and update on Rainfall Intensity Duration Frequency (IDF) and Flood Estimation work in the Asia Pacific Region

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ABSTRACT: This paper summarizes progress on work under the Asian Pacific FRIEND (Flow Regimes from International Experimental and Network Data - APFRIEND) initiative of the International Hydrological Programme (IHP) of the United Nations Educational, Scientific and Cultural Organisation (UNESCO) from 2005 to 2009. The results of initial work on Rainfall Intensity Duration Frequency (IFD) have just been published as a volume by UNESCO. The results of work to date is concisely presented and observations made about lessons learnt on how to successfully integrate work from nine diverse countries with differing approaches to both hydrology and water resource management structures and on some possible directions for future work.

1 BACKGROUND

Flow Regimes from International Experimental and Network Data (FRIEND) is an international research programme that supports regional networks for analyzing hydrological data. It was set up with the objective of improving understanding of hydrological variability across time and space. It achieves this through the mutual exchange of data, knowledge and techniques at a regional level. There are eleven regional FRIEND projects around the world.

During an APFRIEND meeting attended by country representatives from Australia, China, Indonesia, Japan, Korea, Malaysia, New Zealand, Philippines and Vietnam in Kuala Lumpur in June 2005, there was discussion about the different methods used in each country for analysis used to derive rainfall – duration – frequency curves (Known as Intensity Duration Frequency, or IDF) and for Design Flood Determination methods. It was decided to focus on these topics as an APFRIEND project.

2 INITIAL PROCESS ADOPTED

The initial approach was defined at the Kuala Lumpur meeting in June 2005 with additional discussions at a APFRIEND Technical sub-committee meeting associated with the 13th IHP Regional Steering Committee meeting for South East Asia and Pacific in Bali in November 2005 confirming details. The approach adopted can be summarized to:

- Have all 9 counties analyze 9 data sets by the end of 2005
- Send data sets to lead authors by email
- Lead authors (with support from others) to prepare a report
- Lead authors to consider the need for a future technical workshop on IDF.
- Lead authors to consider preparing a paper on the work for a future conference.

Work on Design Flood Determination methods was discussed at the initial meeting in Kuala Lumpur in June 2005, but by November 2005 it was apparent that the rainfall project should be completed first and Design Flood Determination methods should follow consecutively.

3 PROGRESS FROM 2006-2008

The logistics and practicality of sharing data between 9 countries in a collaborative project resulted in measured and steady progress rather than the rapid pace originally envisaged. Reasons for this include:

- The original timetable was very optimistic. In reality most participants in the project were committed to full time activities in their own primary workplaces and could devote limited time to this work.
- The technical component of the work appeared straightforward, but the logistics of accessing, checking and securing approval transfer data took considerable time.
- Access arrangements for data proved difficult. There is considerable sensitivity around data in some countries due to the importance placed on water resources. While these issues were resolved, the resolution process required seeking data access authorization from outside agencies.

At the 16th IHP Regional Steering Committee meeting for South East Asia and Pacific in Ulaanbaatar in October 2008 a draft report was tabled. This report indicated that work on Part 1 (IDF) of the APFRIEND was complete. The next step proposed was an IDF workshop in March 2009. This was to involve 10-15 participants and be a two day meeting with a one day meeting on IDF and a one day meeting on flood estimation methods.

4 PUBLICATION OF RESULTS

During 2008, IDF analysis were received and collated by the lead authors into the 110 page publication Daniell and Tabios III (2008). This report presents material received from all 9 countries on a one chapter per country basis.

The summary of IDF methods in this report is presented in Table 1. Much more information is available in the report which was mounted on the UNESCO Jakarta web site in March 2009.

Table 1: IDF method by country

Country	**Method**
Australia	First fitted three-parameter probability distributions (e.g. generalized logistic, generalized extreme vale (GEV) generalized normal, Pearson Type III, generalized Pareto) to rainfall data. GEV best fit for rainfall duration from 1 hour to 72 hours in majority of cases. L-moments were then used to estimate parameters of the generalised extreme value (GEV).
China	Pearson Type III, with Sherman or Horner formula to fit generalized IDF curve for each station.
Indonesia	Best fitting distributions were normal, lognormal, Pearson Type III, log-Pearson Type III and Gumbel (extreme value type 1) distributions. Estimated intensity duration curves for a given frequency were fitted to parametric function using the Talbot, Sherman or Ishiguro formulas at that given frequency.
Japan	General extreme value distribution was used, and then either the Talbot, Bernard, Kimijima or Sherman equations was fitted to the intensity-duration curves for various frequencies. The final intensity-frequency-duration (IDF) curve was obtained from another equation based on scaling methods to ensure that there is no inconsistency in the intensity-duration curves at different frequencies.
Malaysia	General extreme value distribution was used and then a generalized IDF curve called Bernard equation was applied.
New Zealand	General extreme value distribution was used.
Korea	Various probability distributions were fitted. It was determined that the Gumbel distribution was the best fitting probability distribution for Sydney, Australia, Changzhou, China, Bogor, Indonesia, both Ha Noi and An Nhon , Vietnam and

	for all stations in Korea. The rest of the rainfall stations fitted other distributions such as log-normal for Melbourne in Australia, gamma for Yongcuan, GEV for Bandung Indonesia and log-normal for Nagoya and Ohkusa in Japan, gamma for Empangan Genting kelang of Indonesia, among others. Likewise a generalized IDF curve was fitted for each station after fitting the distributions.
Philippines	Fitted the Pearson Type III distribution which is the standard procedure in the Philippines and then a generalized IDF curve equation was fitted for the rainfall station analyzed.
Vietnam	Fitted the log-Pearson Type III distribution and then a generalized IDF equation

The discussion in Daniell and Tabios III (2008) noted that the IDF analyses employed by the participating countries can be grouped into 2 or 3 approaches. A key difference was that some countries applied the best fitting probability distribution function to each rainfall station data while other countries adopted a single probability distribution to be fitted to all rainfall data. For the latter, 3-parameter probability distributions (i.e., GEV, Pearson Type III or log-Pearson Type III) were used as they were found versatile enough to accommodate all rainfall data.

For fitting IDF parametric or smoothed curves, some countries fitted intensity-duration curves for a given frequency while most countries employed a generalized IDF curve. The use of the generalized IDF equation ensured that the IDF curves result in consistent curves (i.e., intensity-duration curves) at different frequencies. This is in contrast to fitting only an intensity-duration function where the resulting curves may cross each other at the different frequencies. However it was noted that the generalized IDF function used by the various countries cannot perfectly fit the entire empirical IDF curve since the form of the IDF equation with 3 parameters at most cannot be expected to accommodate the observed ranges of rainfall intensities, durations and frequencies unless perhaps a higher-order model or a model with more model parameters is used.

5 IDF AND FLOOD DESIGN WORKSHOPS, HO CHI MINH CITY MARCH 2009

Following completion of Daniell and Tabios III (2008), a one day IDF workshop was held in Ho Chi Minh City in Vietnam in March 2009. This involved participants from the 9 countries involved in the IDF project.

Responses to the content of the report from participants included some common themes including:

- Standardization of symbols, graphs and equations was required.
- The differences in results between countries such as Japan and Australia
- Variations in coverage and completeness of rainfall data between countries

Following the IDF workshop, a one day workshop was held on design flood determination. This workshop took into account the results of the IDF workshop and considered a related APFRIEND Regional Project on flood disaster prevention and mitigation measures in the Asia and pacific Region which is commencing in 2009. This project, entitled “Assessment of Flood Forecasting and Warning Systems for Tropical Regions” will cover three study areas in Vietnam, Indonesia and Malaysia.

Information of design flood determination methods was presented by each of the 9 countries. Particular attention was paid to presentations from Australia, where a major revision of flood design methods is underway and Japan, where significant work is being done using dense network of observing sites and weather radar. A discussion then followed covering methods, noting similarities and differences and then moved to proposed next steps.

6 EXPECTED NEXT STEPS FOR IDF

The highest next priority for is to produce a short supplementary report as a companion volume to Daniell and Tabios III (2008). This supplementary report will include and introduction, a summary of methods used in each country, using a table and a regional map and will standardize terminology for symbols and equations.

During the discussions on IDF it had also been noted that a number of important areas of additional work will be required to both provide robust IDF results and to engage with important related issues such as climate change and disaster prevention and mitigation. These important areas of work include:

- Assessing effect of stationary no longer being valid (Climate variability and change)
- Spatial variation in rainfall, including Areal reduction factors.
- Opportunities to do work on Depth-Area-Duration factors with dense networks of rain gauges and weather radar.

It was concluded that this work should be associated with the next stage of design flood work. The immediate need for IDF work was to complete the supplementary report by November 2009.

7 NEXT STEPS FOR DESIGN FLOOD WORK

The next opportunity for an APFRIEND meeting will be in Wuhan in November 2008. At this meeting a one day workshop will finalize a work plan for design flood work taking into account information including:

- Final reporting for the first stage of the APFRIEND project (IDF).
- Progress on the associated "Assessment of Flood Forecasting and Warning Systems for Tropical Regions" project.
- Potential use of concepts from Australia (review of Australian Rainfall and Runoff) and Japan (intense rainfall variability).
- Information from design flood methods suitable for inclusion into responses to climate variability and change

8 OBSERVATIONS ON THE PROCESS

The APRFRIEND initiative on IDF and flood design has demonstrated cooperation and goodwill between 9 Asia-Pacific Countries with diverse climates and hydrology. Over time it has become more relevant and important due to land use intensification and climate variability and change affecting all 9 countries. This is challenging practitioners and researchers to find solutions to the increased level of risk through both increased probability of occurrence and increased seriousness of damage from heavy rainfall and floods. There is an expectation from society that technology will help mitigate and adapt to these climate risks and collaborative international efforts will contribute to this.

A number of lessons have been learnt from the APFRIENF IDF and flood estimation project to date. These include:

- The importance of making advances in increments that are manageable to all participants. This avoids wasting time.

- The potential value of sharing methods being developed in countries with particular technological strengths. The value is not just the technology itself, but a forum to assess how it could realistically be adapted to other countries needs.
- A realistic approach needs to be taken to sensitive issues such as data access. It may be appropriate to assume that each country may only be able to work with its own data and to formulate work programs that can produce results from such an approach.

Overall the process used in the APFRIEND project has been in place since 2005. It has identified some of the key difficulties with international collaboration in the Asia, pacific region to participants from 9 countries. In response the process can be seen as being refined through "continuous improvement" based on experience. Perseverance with these efforts will allow both benefits to the countries involved and allow future expansion to welcome additional regional partners to benefit from the technical improvements resulting from cooperation and good will.

9 REFERENCES

Daniell, T.M, and Tabios III, G. Q. (2008). "Asian Pacific FRIEND: Rainfall Intensity Duration Frequency (IDF) Analysis for the Asia Pacific Region". IHP-VII Technical Documents in Hydrology No.2, Regional Steering Committee for Southeast Asia and the Pacific, UNESCO Jakarta

Final Report: 13th IHP Regional Steering Committee meeting for South East Asia and Pacific in Bali, Indonesia, 24-25 November 2005, UNESCO Jakarta

Final Report: 16th IHP Regional Steering Committee meeting for South East Asia and Pacific in Ulaanbaatar, Mongolia, 2-3 October 2008, UNESCO Jakarta