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## The Impact of Climate Variability on Farm Households in Central Sulawesi, Indonesia

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### **The ENSO climate phenomenon**

Crop production in the tropics is subject to considerable climate variability, both in a temporal and a spatial dimension (SALAFSKY, 1994; AMIEN et al., 1996; DATT and HOOGEVEEN, 2003). ENSO (El Niño - Southern Oscillation) is the most dramatic phenomenon of natural climate variation on a time scale from few months to several years (LATIF, 1999). In short, an El Niño event can be described as the appearance of abnormally warm sea surface water in the central and eastern Pacific near the equator, which is observed at four-year intervals on average. Folklore suggests that the name 'El Niño' (the Spanish term for 'Christ Child') was used by Peruvian fishermen to describe this phenomenon because it

regularly occurs in December. El Niño is closely linked to a rise in air pressure in South-East Asia and the western Pacific, and a decline in the eastern Pacific – the 'Southern Oscillation' – which causes trade winds to be less pronounced (GLANTZ, 1996; LATIF, 1999).

In South-East Asia, ENSO events are associated with comparatively dry conditions. In four ENSO years between 1973 and 1992, the average annual rainfall was only around 67% of the 20 year average in two major rice growing areas in Java, causing a yield decline of approximately 50% (AMIEN et al., 1996). HARGER (1995) studied ENSO variations and drought occurrences in Indonesia and the Philippines, using atmospheric temperature and rainfall records for the

time period from 1866 to 1992, in which 28 ENSO events were recorded.

ENSO events have raised increasing awareness among scientists, the general public and policy makers concerning the impact of climate variability on natural resource management and food security in the affected countries. In South-East Asia, ENSO aggravates the socio-economic and environmental problems caused by increasing population pressure on fragile agro-ecological zones. To identify appropriate policies to cope with the impact of ENSO, there is a need for interdisciplinary studies which (1) are based on bio-physical and socio-economic data and models on the meso-and micro-scale, and (2) include - in a participatory approach - the perceptions, reac-



Aufnahme: Constanze Leemhuis 2003

Photo 1. Data readout at one of eight IMPENSO climate stations in co-operation with the Indonesian meteorological service. The establishment and maintenance of the stations involve the local population.

tions and adaptation strategies of rural households and local communities.

### The IMPENSO project

IMPENSO (IMPact of ENSO) is an interdisciplinary research project which investigates the impact of ENSO on water resources and the local communities in the Palu River watershed of Central Sulawesi, Indonesia. Its overall objective is to quantify the local and regional manifestations of global climate variability, analyse their implications for water resources and agricultural land use, and assess their socio-economic impact on rural communities living in agro-ecologically sensitive regions. To fulfill this overall objective, the project consists of three interrelated sub-projects that pursue the following specific objectives:

#### The climatological sub-project A 'Climate Variability and ENSO':

- Analysis of rainfall variability and distribution patterns using data from existing and newly established climate stations (Photo 1).
- Verification of the numerical results of the large-scale general circulation model of the European Centre for

Mediumrange Forecast (ECMWF), and nesting it with the regional hydrostatic climate model REMO.

- Down-scaling of the REMO model to resolve the local conditions within the mountainous research area.
- Prediction of the atmospheric conditions and soil water content in the research area on a time scale of several months.

#### The hydrological sub-project B 'Impact of ENSO on the Water Budget':

- Installation of river stage recorders to analyse water discharge patterns.
- Preprocessing of spatial data on geology, soil types, and vegetation as input for the hydrological model.
- Application of the distributed hydrological model WaSiM-ETH, and integration of regionalized climatic parameters provided by sub-project A.
- Assessment of the impact of climate variability and land use change on the water budget.
- Simulation of climate and land use scenarios with the validated hydrological model concerning future trends in water availability, to be integrated in sub-project C.

#### The socio-economic sub-project C 'Socio-economic and Policy Implications of ENSO':

- Application of participatory research

methods to assess the perceptions, the knowledge, and the coping strategies of the local population with regard to ENSO (Photo 2).

- Interviewing a stratified random sample of farm households in the Palu watershed to assess the impact of ENSO at the plot and farm household level.
- Estimation of production functions of the most important crops in the research region to quantify the impact of ENSO-related climate variability on their yields.
- Performing a household susceptibility analysis and developing a linear programming model to simulate farm household decision-making, integrating data generated by sub-projects A and B.
- Combination of the simulation model with participatory methods involving local stakeholders in order to derive policy recommendations.

### The IMPENSO research area

The research area of the IMPENSO project is the Palu River watershed in Central Sulawesi Province, Indonesia (Fig 1). The watershed covers an area of 2694 km<sup>2</sup>, and is characterized by a very high bio-physical and socio-economic diversity. The coastal region around the provincial capital Palu with four to six arid months and an annual precipitation of only 600 mm is among

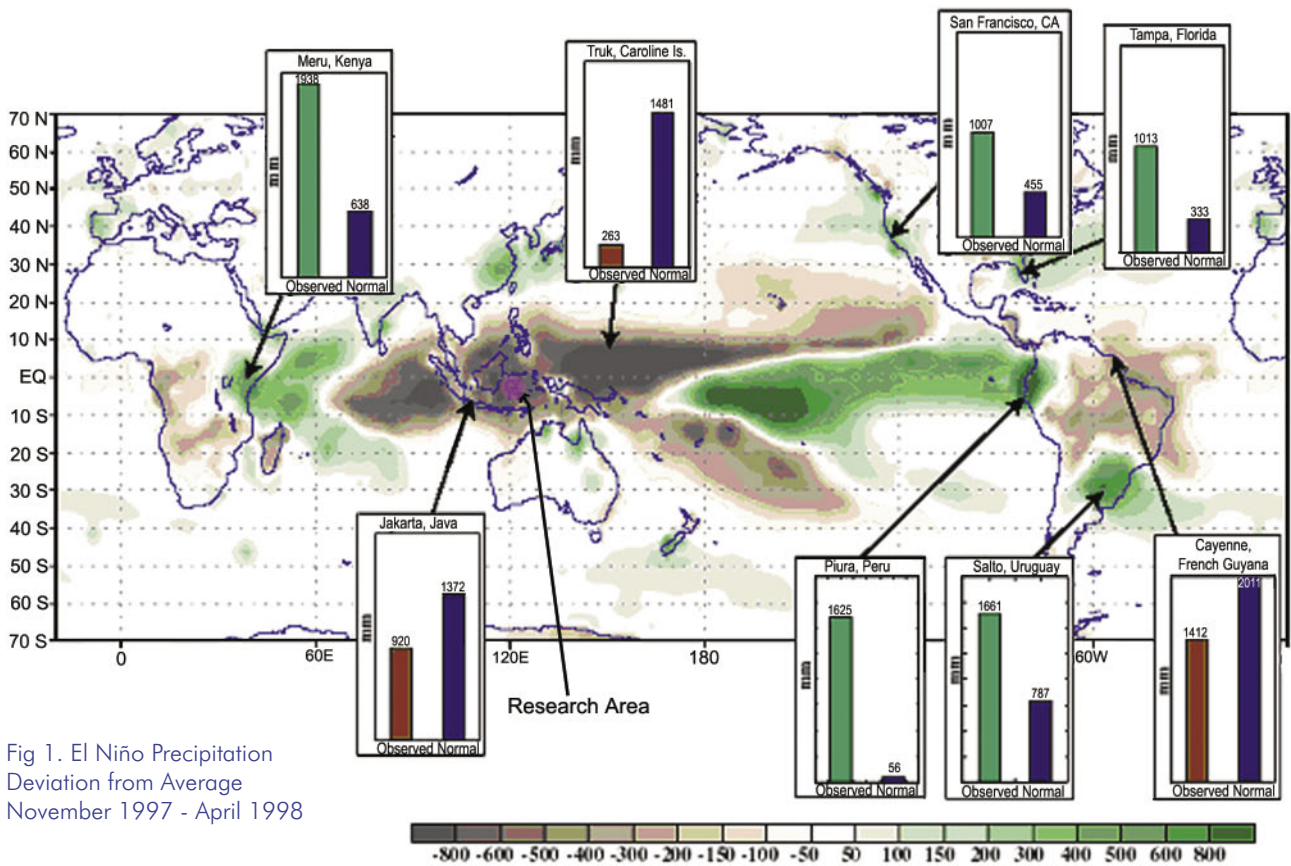


Fig 1. El Niño Precipitation Deviation from Average November 1997 - April 1998

the driest regions of Indonesia. The climatic conditions change dramatically when approaching the nearby mountain regions where precipitation increases to more than 2000 mm per year, and rainforest vegetation prevails. The population of the research region comprises approximately 30,000 people. The ethnic diversity of the indigenous population has increased through rapid in-migration. The rural areas are characterized by a high incidence of poverty, and the population mostly relies on agricultural production. The low-lying Palu valley is an important rice growing area, at higher

elevations rice and cocoa are the two dominant crops.

**The socio-economic impact of ENSO on farm households – an overview of findings**

Data were collected in eight randomly selected villages within the Palu River watershed, whereby the elevation of the village above sea level was used as a stratification criterion. In all research villages Rapid Rural Appraisals (RRA) were conducted, during which farmers discussed issues related to climate variability (Photo 2). Using the RRA results, a

detailed questionnaire for a survey of 228 randomly selected farm households was developed, which was conducted from October 2002 to February 2003.

Eighty-three percent of the sample households have been negatively affected by at least one drought since they have been living in their particular village. According to the respondents, the most severe droughts occurred in 2002 (59% of respondents) and in 1997/98 (15%). Both are acknowledged to have been times of ENSO events; however, in their assessment, respondents may have been biased towards the most recent drought experienced.

Regarding the perceived length and severity of drought periods, differences were observed within the mountainous research region, with low-lying areas being more seriously affected than higher elevations. On average, the most severe drought had caused the yields of the two dominant crops, irrigated rice and cocoa, to decline to about 70% of their usual level. Apart from elevation, yield declines in rice largely depend on the kind of irrigation facilities available.

In order to cope with decreased agricul-

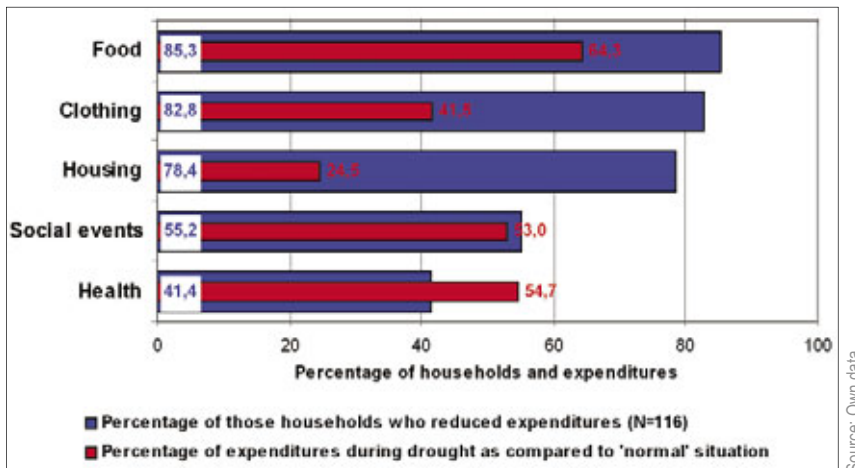


Fig 2. Reduction of household expenditures as a reaction to decreased agricultural income due to drought in Central Sulawesi.



Aufnahme: Alwin Keil 2003

Photo 2. Data collection using participatory methods.

tural income due to drought periods, 62% of the affected households had to reduce consumption expenditures, 46% earned income from sources that are usually not utilized, and 21% took a loan (multiple responses possible). Fig 2 provides a more detailed overview of expenditure reductions in different categories. For example, it shows that 85% of households who were not able to maintain their usual level of consumption expenditures spent less on food, and they reduced expenditures in this category to 64% of the normal level. The dominant additional income sources during the drought were temporary employment (72%), and the illegal extraction and sale of rattan from an adjacent national park (28%, multiple responses possible).

In summary, one can conclude that despite the location in a rainforest area, farmers in Central Sulawesi face a substantial risk of recurring drought periods which are related to ENSO events. Preparedness for the case of drought through precautionary measures is generally poor. Hence, risk management is

usually confined to ex-post coping measures, once the household already faces the drought. The majority of farm households have to cut expenditures to adapt to the drought-induced reduction of agricultural income. All domains of basic needs are affected, whereby the drastic cuts in food expenditures are particularly alarming, suggesting that drought events seriously impair the nutritional status of farm households in the area.

#### Anmerkungen

Das IMPENSO Projekt ([www.user.gwdg.de/~impenso](http://www.user.gwdg.de/~impenso)) ist Teil des vom Bundesministerium für Bildung und Forschung finanzierten Deutschen Klimaforschungsprogrammes DEKLIM ([www.deklim.de](http://www.deklim.de)).

Insgesamt sind am IMPENSO Projekt beteiligt:

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Im Rahmen des Projektbereiches C promoviert Alwin Keil ([Alwin.Keil@agr.uni-goettingen.de](mailto:Alwin.Keil@agr.uni-goettingen.de)) am Institut für Rurale Entwicklung ([www.user.gwdg.de/~uare](http://www.user.gwdg.de/~uare)) der Universität Göttingen zum Thema 'The socio-economic impact of ENSO-related climate variability on farm households in Central Sulawesi, Indonesia'.