FINAL TECHNICAL REPORT **April 1996**

Satellite Agro-Meteorology

Programme: NRS1P
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Executive Summary

This project concentrated on the demonstration that satellite imagery can provide a level of agrometeorological data to complement sparse observations at the surface, and that combined with local knowledge, such data can provide useful information to local resource managers. Best current methodologies were assessed, adapted into operational prototypes when appropriate. and demonstrated on practical cases including a veterinary application in Namibia, rice production, irrigation planning and land use changes in Indonesia, and malaria studies in Africa. Outputs and publications have promoted substantial interest from local and scientific communities. The project has contributed to ODA's development goals by applying remote sensing and G1S techniques to demonstrate how people in the field can benefit from free, readily available environmental data. Further adaptive research and implementation work is now necessary to transform these prototyping activities into fully validated and operational units.

Background

Agro-meteorological data in developing countries are often sparse, irregular, unreliable and both expensive and slow to collect, process and disseminate. Nevertheless, such data (e.g., temperature, evaporation, radiation, vegetation status) are linked to various processes (e.g., pathogen insect development, crop growth, famine prediction, water management), and therefore can be of great use to workers of forestry, veterinary services, irrigation planning, plant protection, early warning, hydrology, etc. particularly if they are available in timely fashion.

Project Purpose

The objective of the project is to determine the potential or satellite imagery (.free, direct access, real time) (i) to monitor changes in agrometeorological variables, (ii) to provide real time fine resolution information to complement sparse observations at the surface, and (iii) to demonstrate that when incorporated in environmental information systems, and combined with data from other sources, extracted agrometeorological variables will provide information useful far the local resource managers, Three main activities were undertaken: (i) to assess existing methodologies to extract agro-meteorological variables from remote sensing in terms of operational use (ii) to develop and adapt into operational prototypes those methods that could be implemented without requiring major basic research, (iii) to demonstrate in actual cases the capabilities of the approach.

Research and Outputs

Identification of necessary agro-ecological and agro-meteorological variables.

A selection of important. agro-meteorological variables that could potentially be retrieved from satellite data were identified. These are vegetation status.. land surface temperature, net radiation and evapotranspiration.

Identification of appropriate remote sensing techniques to monitor agro-meteorologicol variables.

For each of the above variables, literature surveys and data analysis have been undertaken to assess current methods available using remote sensing techniques to extract the above variables from remote sensing, and to identify priorities for further development and validation.

It is concluded that whereas indicators of vegetation status and land surface temperature are valuable when relative information is required, extracting evapotranspiration with accuracy requires better estimation of the net radiation and land surface temperature. The latter requires a better assessment of emissivities. These require then substantial research and validation.

Vegetation and land surface temperature, as well as a first approach to emissivities assessment have been integrated in the NOAA Operations Manager (NOM), currently under development under the ODA-funded Remote Sensing Africa Regional project.

Practical demonstration of the potential for using remotely sensed data by local natural resources managers.

In collaboration with practical projects, it has been demonstrated how managers can already benefit from using estimation of agro-meteorological variables.

a) Direct use of METEOSAT in a veterinary application in Namibia. (Flasse *et at,* 1995)

The Veterinary Department of the Ministry of Agriculture, Water and Rural Development of Namibia issues warnings to farmers in the south of the country concerning the likelihood of infestation by the small-stock nasal fly, *Oestrus ovis.* Farmers can then treat their stock at the most appropriate time. The *Oestrus ovis* pupae over-winter at shallow depths in the soil and the timing of emergence is directly dependant on climatological conditions, specifically the number of degree-days above a particular threshold soil temperature. Based on temperature measurements from only a few stations scattered throughout the country, the Veterinary Department warnings lack precision in space and time. This application demonstrated how accumulated temperature information from METEOSAT images could help to better assess the place and time of hatching and improve the precision and reliability of warnings given to farmers.

b) A malaria application in Africa (Thomson *et al.,* 1995)

In collaboration with the Liverpool School of Tropical Medicine, a study was carried out to show how agro-meteorological variables estimated from remote sensing could successfully be incorporated along with other data into a geographical information system to contribute to the goals of monitoring malaria transmission patterns, predicting epidemics and planning control strategies.

C) Rice production in Indonesia (Mubekti *et al.,* 1996)

In collaboration with the ODA-funded Indonesian-UK Environment Monitoring Project, it has been shown that indicators of land surface temperature and vegetation status from NOAA AVHRR data provide useful information on rice development, which, in turn, could be used for qualitative and timely pre-harvest assessments. Initial results are encouraging, with a good correspondence between NOAA and field observations. This correspondence suggests that free NOAA data, integrated with more detailed field and satellite studies, could provide the basis for a national (pre-harvest) production forecasting system.

d) Irrigation planning in Indonesia (Rahmadi *et at.* 1996)

During the dry season, water is very precious. When the demand for irrigation water starts overtaking its availability, the water manager has to make difficult choices. In collaboration with the ODA-funded Indonesian-UK Environment Monitoring Project, this application demonstrates how NOAA AVHRR data (indicating water deficit and vegetation status) can contribute to the prioritisation of water delivery, as well as monitor the state and evolution of the crops. These indicators could be used to help watershed managers assess the performance of the annual irrigation plan and prioritise water flow to balance the opposing demands of water conservation and irrigation demand.

c) Identifying forest changes in watershed manag[g]ement in Indonesia. (Hartanto *el at,* I996)

The ability to monitor vegetation loss over land areas susceptible to degradation is of great potential use in watershed management. Such information can assist in prioritising land use planning, rehabilitation and regulation activities to preserve and protect critical areas. This in turn can help to reduce soil erosion and associated sedimentation problems, improving water conservation and reducing the possibility of flooding. In collaboration with the ODA-funded Indonesian-UK Environment Monitoring Project, a prototype technique was demonstrated for monitoring land use changes occurring within critical watershed areas. The magnitude of AVHRR-derived vegetation changes was cross-referenced with critical land status as a basis for prioritising management action. The approach is flexible, and could be enhanced in numerous ways according to specific management requirements, such as in forest-agriculture interface, Incorporation

of other information from local or satellite sources (such as seasonal trends) is seen as an essential further step to increase the robustness of the technique.

Contribution of Outputs

The project has contributed to ODA's development goals by applying remote sensing and GIS techniques to demonstrate how people in the field can benefit from free, readily available environmental data. More specifically, it has demonstrated that

- remote sensing data can provide a first assessment of some agro-meteorological variables,
- when integrated with local knowledge. the freely available remotely sensed data offer temporal and spatial information on the environment and agriculture.
- such information can be of great value to help natural resources manager in areas such as yield forecasting, forest/agriculture changes, and pathogen insect development control, and focus their efforts to achieve greatest impact.

The various demonstrations illustrated by the outputs have already promoted a lot of interest from practical users in the field. In Namibia the Veterinary Services are interested in improving and using the current installed methodology. In Indonesia, various institutions have officially requested help (through the ODA-funded **Indonesian-UK** Environment Monitoring Project) in implementing satellite reception and using derived agro-meteorological information (e.g. BULOG-National Rice Stock Agency, BPS-National Statistical Agency, P.T. Jasa Tirta-watershed management company, Ministry of Forestry- INTAG). In Argentina, the Centro de Investigagiones Entomologicas has suggested collaboration to support the mosquito control programme (Aedes albifasciatus, whose development is dependent on surface temperature conditions, and affects milk and beef production), NR1 has recently been included in an ODA project to support work on the control of Malaria outbreaks. Similarly, an ODA-funded project to monitor locust outbreaks in Eritrea has shown interest in the developed approaches. Finally, collaborations with projects in Nicaragua (MARENA - Ministero del Ambiente y Recursos Naturales- support for environment monitoring through local satellite data reception) and Indonesia (UK-Indonesia Tropical Forest Management Project-ITFMP, and EU-Indonesia Forest Sector Support Program-IFSSP), should soon use the approaches developed in this project for the mapping of vegetation fire risk.

Dissemination Outputs (Publications)

Thomson, M. C.. S. J. Connor. P. Milligan, S. P. Flasse (1996) 'The ecology of malaria - as seen from earth observation satellites'. *Annals of Tropical Medicine and Parasitology, in* print.

Mubekti, Gatot Hendrarto, Suyono. S. N. Trigg, J Taylor, and S. P. Flasse (1996) 'The role of NOAA AVHRR for acquiring information on rice production in Indonesia' in *Proceedings of workshop on Direct Reception of Satellite Data for Integrated and Sustainable Environmental Monitoring in Indonesia, April 16, 1996, BPI" Teknologi, Jakarta, Indonesia,* 8/1-16.

Hartanto. S. N. Trigg, S. P. Flasse, and A. Karsidi (1996) 'Identifying land use changes in critical areas for watershed management' in *Proceedings of workshop on Direct Reception of Satellite Data for Integrated and Sustainable Environmental Monitoring in Indonesia, April 16, 1996, BPP Teknologi, Jakarta, Indonesia,* 9/1-12.

Rahmadi. A., A. Karsidi, L. Sumargana, S, N. Trigg, and S. P. Flasse (1996) `Irrigation planning supported by NOAA AVHRR data' in *Proceedings of workshop on Direct Reception of Satellite Data for Integrated and Sustainable Environmental Monitoring in Indonesia, April 16, 1996, BPP Teknologi, Jakarta, Indonesia,* 10/1-14.

Thomson, M. C., S. J. Connor, P. Milligan, S. Flasse and M. W. Service (1995) 'The potential in using environmental monitoring satellites to predict malaria epidemics in Africa' The 1995 Meteorological Satellite Data Users' Conference, Winchester, UK, 4-8 September 1995, EUMETSAT. Germany, 461-472.

Flasse, S. P., P. Stephenson, P. Hutchinson, and C. Walker (1995) `Direct use of METEOSAT in veterinary application The 1995 Meteorological Satellite Data Users' Conference, Winchester, UK, 4-8 September 1995, EUMETSAT, Germany. 453-459.

Other Outputs

Ceccato P (1995) Literature review on land surface temperature from remote sensing

Ceccato P (1996) Literature review on evapotranspiration from remote sensing

Burt P (1996) A review of the literature pertaining to surface radiation measurement from satellite, for application to agroecological problems.

Burt P and Ceccato P (1996) The use of satellite remotely-sensed data in agroecotogical investatagions: current techniques and recommendations for future studies.
