Assessing the probability of land submergence for lowland rice cultivation in northern Ghana

Sub-Saharan African countries are being strongly urged to enhance their rice production, because their rice consumption and importation rates have been rapidly increasing in recent years. Areas planted to rice in Africa are classified agro-ecologically into rainfed upland, rainfed lowland, and irrigated. Rainfed lowland includes extensive areas of unexploited land that has great potential for the promotion of rice-growing. To develop low-cost rice-farming systems that require no large-scale irrigation or land reclamation, it is important to select suitable areas where water for rice-farming can be obtained naturally; floodwaters offer promise for this purpose. Here, we propose a method of assessing flood probability from submergence frequency, as estimated from satellite imagery and geospatial data.

ALOS/PALSAR images acquired in May, June, August, and September 2010 were used to classify land and water, and then a submerged-area map was produced. In the study site, submergence frequency (y) was approximated by distance from reservoirs (x):

$y = -1.281\ln(x) + 9.0566$ ($R^2 = 0.9415$) (Fig. 1)

Flood extent derived from reservoirs was simulated using Digital Elevation Model (DEM) and the flood simulation program “SimFlood,” which was developed during the study. The results implied that the submerged areas identified by PALSAR were distributed in areas where flood water inflow exceeded 20 times (Fig. 2).

A flood probability assessment map was produced by integration of the estimated submergence frequency and flood extent simulation (Fig. 3). Validation of results using field monitoring data obtained in September 2011 confirmed the adequacy of the estimation (Table 1). Thus the possibility of floodwater use in the study area could be adequately determined.

The flood simulation program “SimFlood” is available for distribution in executable form. When DEM and water resources map can be prepared, the probability assessment of land submergence in other similar areas would be possible.

All-weather microwave sensors that can penetrate clouds have substantial advantages, particularly in identifying the extent of water resources during rainy season. ALOS/PALSAR has been inactive since April 2011, however, archived data are available for analysis.

(Y. Yamamoto, Y. Tsujimoto, Y. Fujihara [Ishikawa Prefectural University], J. Sakagami, M. Fosu [Savanna Agricultural Research Institute])

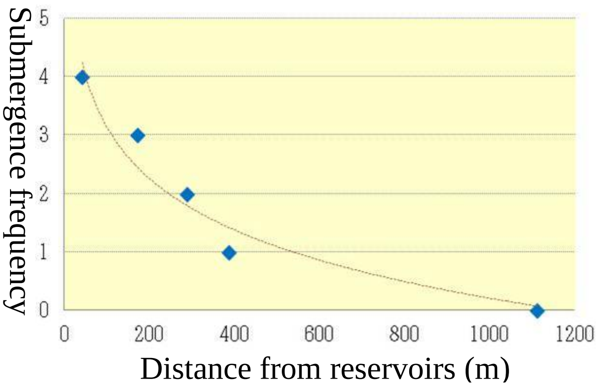

Fig. 1. Relationship between submergence frequency and distance from reservoirs

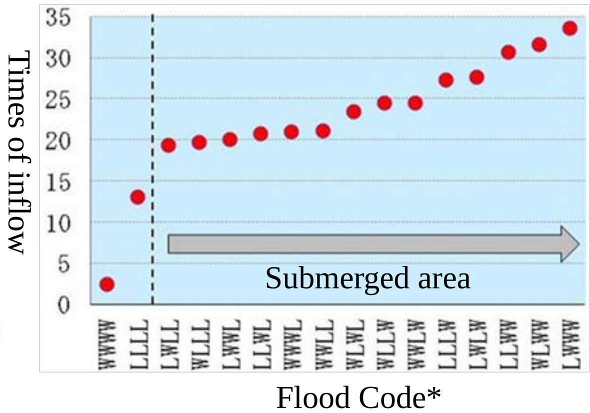

Fig. 2. Times of inflow by flood water in submerged areas

* The results of classification in May, June, August, and September (from bottom to top). W: submerged; L: not submerged.

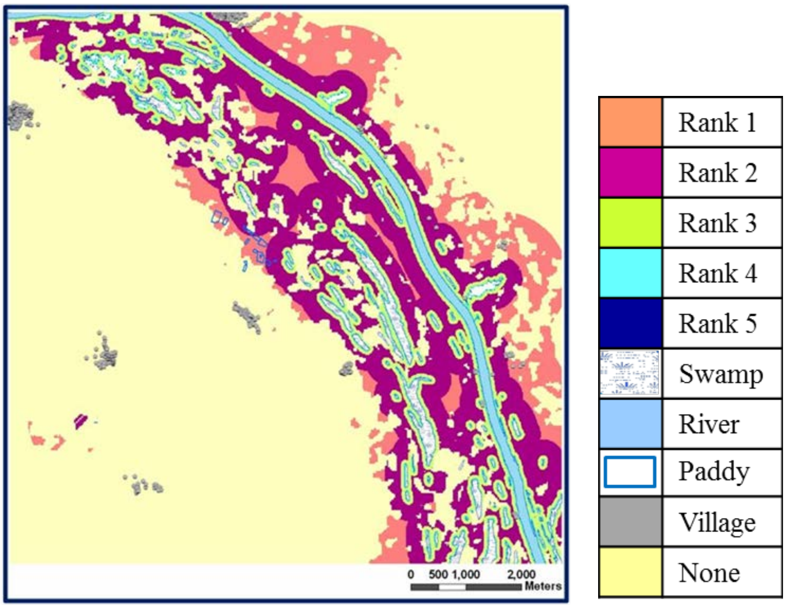

Fig. 3. Flood probability map assessed by geospatial features

Table 1. Soil moisture* by flood probability assessment rank

Flood probability rank	Soil moisture*
None	0.776
Rank 1	0.786
Rank 2	0.819
Rank 3	0.856
Rank 4 & 5 (water boundaries)	0.879

* Average values measured using a portable soil moisture meter equipped with a voltage sensor (DIK-311K, Daiki Rika Kogyo Co.).