Mapping abiotic stresses of rice

AfricaRice has invested — and continues to make significant investments — in developing rice varieties tolerant to abiotic stresses. But are these varieties getting to the farmers who need them and are we testing them in the right sites?

Answers to these questions could partly be provided through the approach of mapping, which allows the identification of areas where rice is grown under particular stress conditions. AfricaRice crop modeler Pepijn van Oort spent four years preparing such maps for four abiotic stresses.[5]

Drought and cold were simulated for representative sites with the ORYZA2000 crop growth model (AfricaRice version) and then extrapolated using a (Köppen–Geiger) climate zone map. In each country (12 for drought and 19 for cold), a number of sites were selected in major rice-growing areas in different climate zones with the aid of a program developed by the 'Global yield gap atlas' (GYGA) project. For each site, crop growth was modeled with ORYZA2000 (AfricaRice version), AgMERRA weather data and two soil types (typical upland and typical lowland).

"As an off-shoot from this project, we developed the AfricaRice Weather Database," says van Oort, "which is freely available online."[6]

Iron toxicity and salinity risk were mapped with a soil map (Harmonised World Soil Database) and crop maps. All these source data are in the public domain and are open access.

Drought mapping proved problematic as local variation (due to topography) is greater than climate-induced variation. Consequently, mapping on a continental scale is inappropriate and needs to be done at the local level. The work broadly determined, however, that drought is the major abiotic stress likely to affect a third of the rice area in Africa.

Conversely, severe cold was well mapped to specific climate zones but affects only 3–7% of the rice area and these are mainly concentrated in the Sahel and highlands. While iron toxicity is a potential threat in 12% of the cultivated rice area (*see* example map of Côte d'Ivoire), salinity is a problem in just 2% of the cultivated rice area.

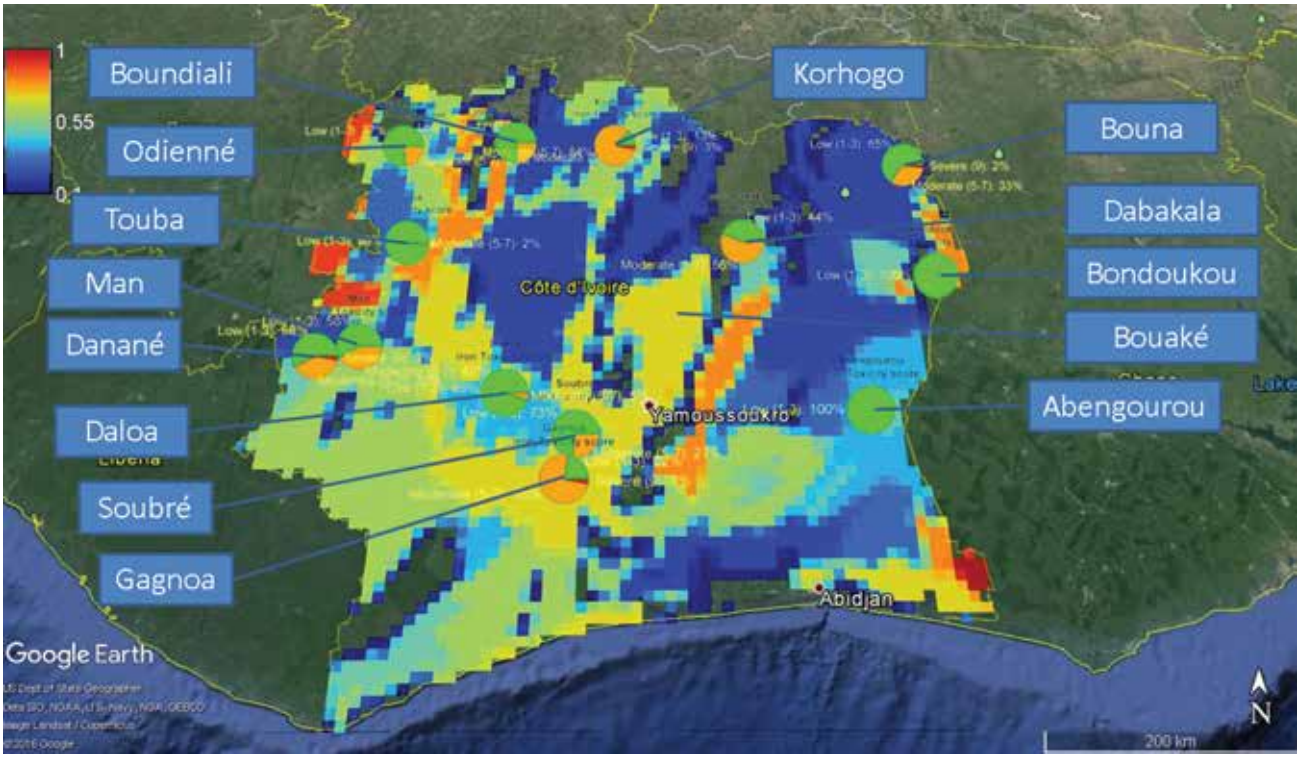
Direct and indirect effects of iron toxicity in inland valleys can lead to 40–45% rice yield reductions in lowlands.

Salinity was well mapped for inland sites, but the resolution of the mapping somewhat masked the major impact of salinity in narrow coastal mangrove agro-ecosystems.

With the maps and accompanying tables generated, development agents are better positioned to target stress-tolerant varieties to those countries and areas

5.van Oort PAJ. 2018. Mapping abiotic stresses for rice in Africa: Drought, cold, iron toxicity, salinity and sodicity. *Field Crops Research*, 219: 55–75. doi: 10.1016/j.fcr.2018.01.016.

6.http://eservices.africarice.org/weatherdata/index.php



Iron-toxicity risk in Côte d'Ivoire

Probability (0–1, legend top left) of presence of iron-rich soil, on the standard background of Google Earth. Such maps are available for all African countries. The added pie charts show the frequency of observed leaf bronzing — low (green), moderate (orange) and red (severe) — used for validation.9 Note: iron toxicity occurs almost solely in poorly drained rainfed lowlands and very rarely in rainfed uplands or well-drained irrigation schemes; in the calculations of area potentially affected by iron toxicity, this soil map was combined with a rice area map.

that need them. At the same time, the data enable researchers to select stress hot spots in the various climatic zones that are close to non-stress areas for screening their materials.

"AfricaRice has a good track record in variety dissemination, particularly with the NERICA varieties in the early 2000s," says van Oort. "The outputs of this project mean that we now have the means to disseminate the new generation of stress-tolerant varieties to those areas that desperately need them."

All the maps and tables generated by the project are publicly available.[7]

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7.https://dataverse.harvard.edu/dataverse/AfricaRice?q=Abiotic+stress+maps+for+rice+(STRASA)

8.Current affiliation: Wageningen Plant Research.

9. Chérif M, Audebert A, Fofana M and Zouzou M. 2009. Evaluation of iron toxicity on lowland irrigated rice in West Africa. *Tropicultura*, 27: 88–92.