



## Modelling spatio-temporal dynamics of malaria and mortality to develop optimised interventions and surveillance tools in Africa

### Overarching goal

Reduce malaria burden in Africa by developing and validating tools (methods, knowledge, software) to strengthen malaria surveillance for disease control and elimination.

### Specific objectives

1. Assess spatio-temporal dynamics of malaria risk and measure effectiveness of related interventions at local scale in Africa
2. Estimate the malaria-related mortality across all age groups in Africa.
3. Assess spatio-temporal dynamics and obtain up-to-date high resolution estimates of infant and child mortality across Africa.
4. Estimate the contribution of health systems performance and interventions in the spatio-temporal dynamics of malaria and mortality (child and maternal).
5. Propose strategies to optimise health systems performance and interventions to reduce malaria and mortality burden.
6. Develop and disseminate software for malaria surveillance (i.e. Bayesian geostatistical malaria mapping and early detection of malaria outbreaks).

### Expected scientific contributions

Results of the project will be:

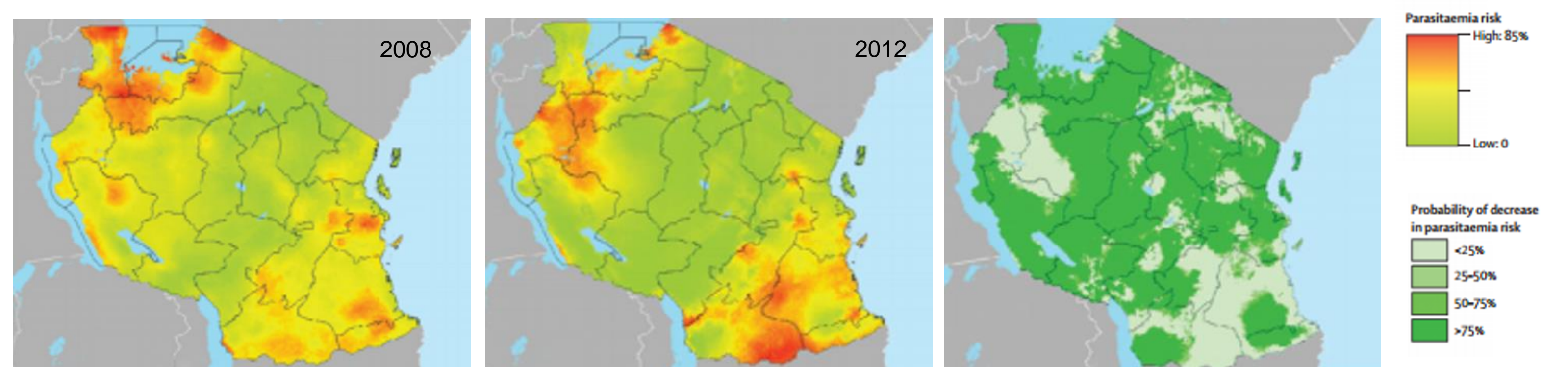
- Rigorous data-driven spatial statistical models tailored to the analysis of Malaria Indicator Survey (MIS), Demographic Health Survey (DHS) and other health survey data.
- Up-to-date spatially explicit estimates of malaria burden (risk and number of children infected) for countries with Malaria Indicator Surveys (MIS) in 2006-2015.
- Continent-wide maps and spatially explicit estimates for infant and under five years old mortality.
- Estimates of the spatio-temporal dynamics of malaria and mortality.
- A quantification of the relation between malaria exposure and mortality across different age groups and levels of endemicity.
- Geo-referenced estimates of the number of malaria attributed deaths at the countries with MIS during 2006-2015.
- Malaria and mortality-specific indices of health system performance.
- Estimates of the effects of interventions in reducing malaria and mortality burden.
- Predictions of cost-effectiveness of interventions at a given location based on the malaria risk.
- Identified gaps in effective delivery of interventions and health services in relation to mortality and malaria burden in Uganda and Burkina Faso.
- Novel statistical methods for early detection of outbreaks.
- Software for malaria surveillance which performs Bayesian geostatistical analyses of MIS data and early detection of outbreaks.

### Development relevance

- Results will be translated to tools (e.g. maps, burden estimates, cost-effectiveness of interventions, strategies to improve health system performance, surveillance software) that can assist efforts of the control programmes towards malaria elimination and reduction of mortality.
- These products can be used to influence policy makers to choose appropriate interventions and improve local health systems in Uganda and Burkina Faso in a targeted way.
- The project builds capacity in advance statistical modelling by giving the opportunity to (i) 2 PhD students from Uganda and 2 PhD students from Burkina Faso (ii) 2 MSc students from Ghana and Cameroon and (iii) 1 Post-doctoral scientist from the CRSN in Burkina Faso to be trained in advanced methods on disease mapping, Bayesian spatio-temporal modelling and computation.

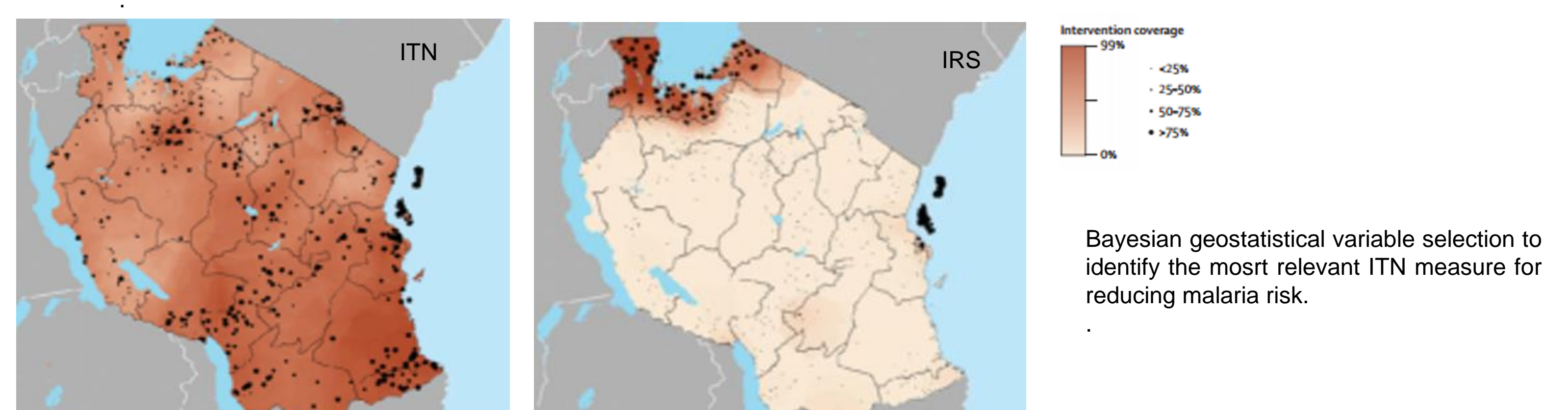


Kick-off workshop in Ouagadougou jointly organised with the MoH



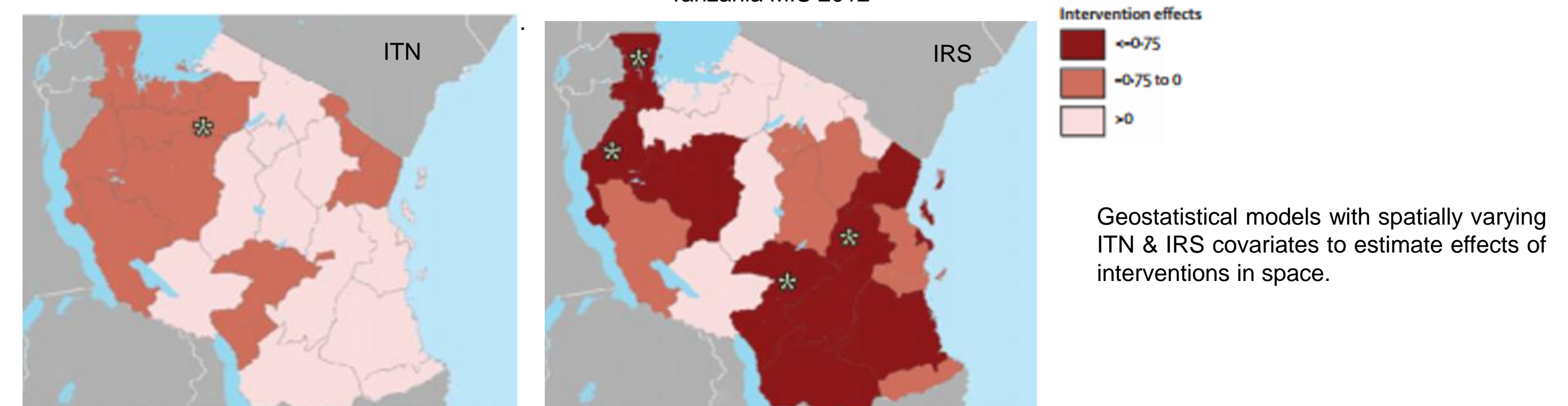
Predicted parasitaemia risk in children under 5yrs in 2008 and 2012. Tanzania AIS/MIS data

Probability of observing a decline in parasitaemia risk in Tanzania in the time period 2008 – 2012.



Proportion of households with at least one insecticide treated net (ITN). Tanzania MIS 2012

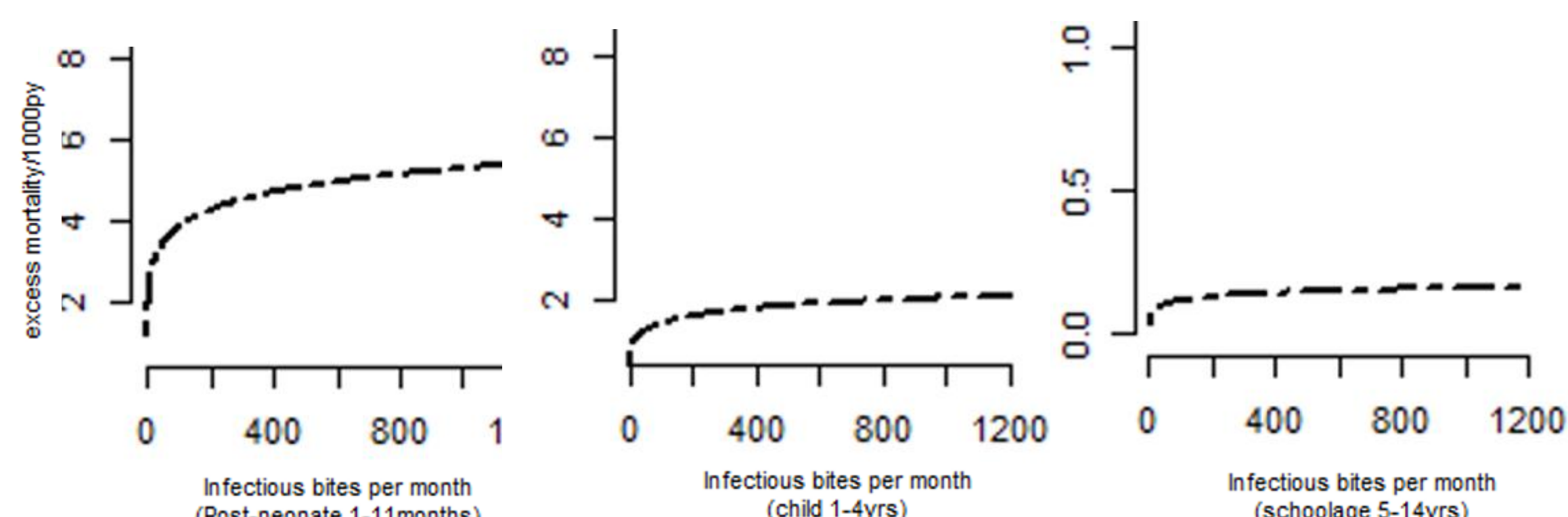
Proportion of households with indoor residual spraying (IRS) during the last 12 months. Tanzania MIS 2012



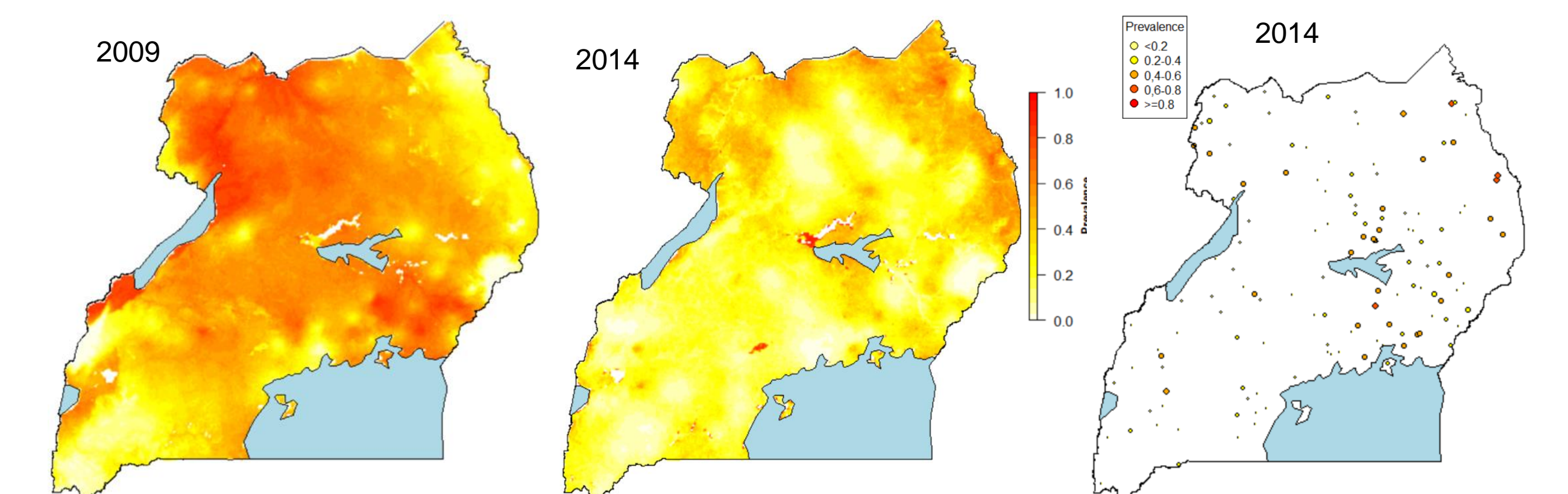
Effects of interventions at sub-national level on changes of parasitaemia risk. (\*) indicates a statistically significant effect.

	Number of infected children (last survey)	Number of infected children (difference)	Prevalence difference
Angola (2006-07 to 2011)	290 817 (285 030 to 296 603)	315 451 (307 507 to 318 395)	0.09 (0.09 to 0.10)
Liberia (2008-09 to 2011)	152 318 (149 148 to 153 486)	26 535 (23 930 to 28 139)	0.04 (0.03 to 0.04)
Mozambique (2007 to 2011)	1 222 360 (1 159 052 to 1 225 668)	-3 981 (-9 258 to 12 95)	0.00 (-0.00 to 0.01)
Rwanda (2007-08 to 2011)	18 639 (18 199 to 19 077)	13 457 (12 632 to 14 282)	0.01 (0.00 to 0.01)
Senegal (2008-09 to 2010-11)	53 935 (53 343 to 54 525)	36 433 (35 445 to 37 421)	0.02 (0.02 to 0.02)
Tanzania (2007-08 to 2011-12)	1 168 438 (1 121 895 to 1 172 980)	503 169 (457 736 to 508 602)	0.06 (0.05 to 0.06)

Number of infected children related to the second survey period, estimated number of infection differences, and model-based estimates of reduction in national level prevalence. Estimates are posterior median (95% credible interval).

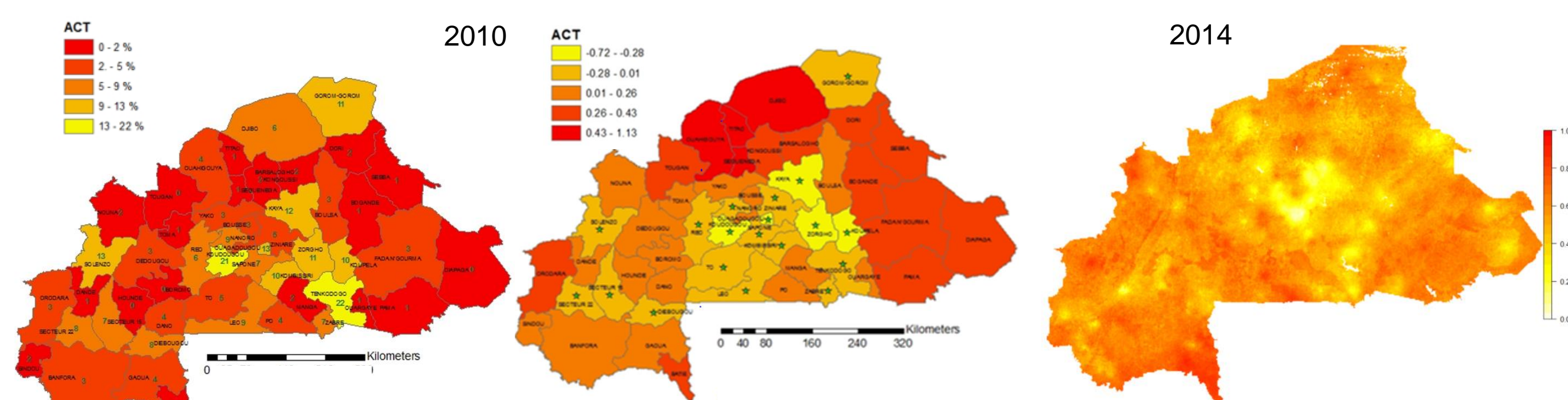


Relation between age-specific all-cause mortality and malaria transmission. Data from the Malaria Transmission Intensity and Malaria Burden in Across Africa (MTIMBA) project and the Nouna - Health and Demographic Surveillance Systems (HDSS).



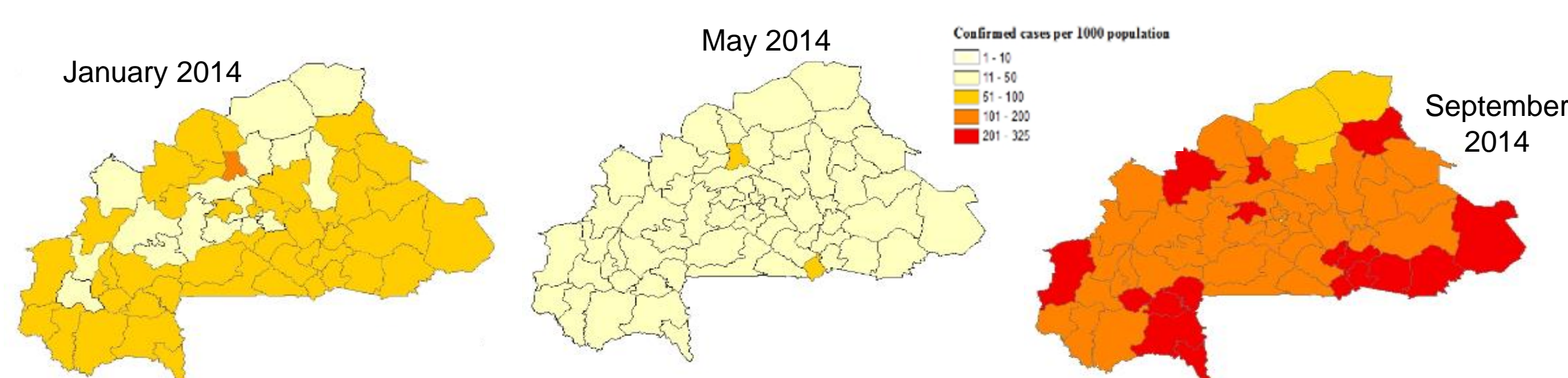
Parasitaemia risk in children under 5yrs old estimated from Bayesian geostatistical models. Uganda MIS of 2009 (left) and 2014/15 (right).

Raw data



Proportion of children under 5yrs who received timely first line Artemisinin-based Combinations Therapy (ACT) out of those reported fever 2 weeks prior to the survey (left) and effects of ACT coverage on the spatial distribution of parasitaemia risk. Burkina Faso MIS 2010.

Parasitaemia risk estimates in children under 5yrs old. Burkina Faso MIS 2014.

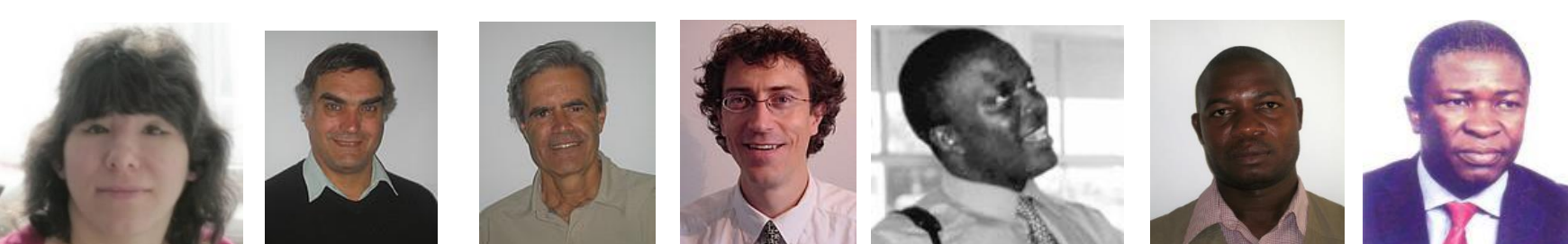


Spatio-temporal models of malaria confirmed cases. Health information systems data. Burkina Faso 2014.

### Project organisation and team

The project consists of (i) the Swiss TPH group (ii) the group from the School of Public Health at Makerere University (MAK) in Uganda and (iii) the group from the Centre de Recherche en Santé de Nouna (CRSN) in Burkina Faso.

#### Applicants



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#### Project team



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