Vector Hazard Report: West Africa

Part 1: Background and Mosquito Borne Diseases

Information gathered from products of The Walter Reed Biosystematics Unit (WRBU):

Systematic Catalog of Culicidae
VectorMap

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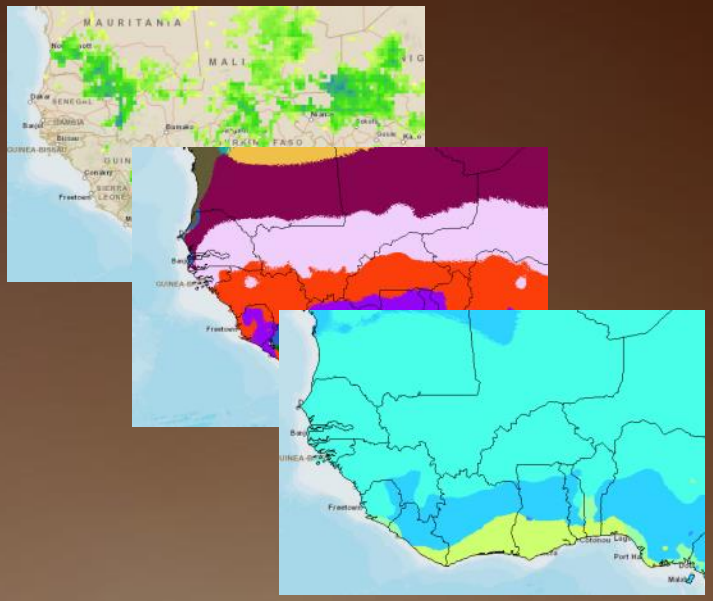

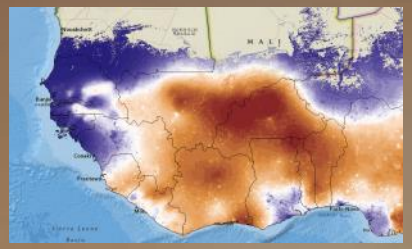

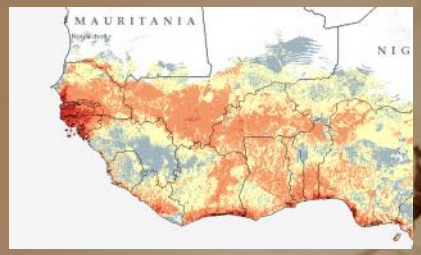

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Background

There are a number of vector hazards to consider in West Africa. Mosquito, Sand Fly and Tick-borne diseases are prevalent throughout the year. The vectors of malaria, dengue fever, chikungunya virus, yellow fever, West Nile virus, Rift Valley fever, Japanese encephalitis, Leishmaniasis and Crimean-Congo hemorrhagic fever occur in this area. The purpose of this brief is to help those traveling to and living within West Africa to learn more about their risk of vector-borne disease infection. All maps are available for download on VectorMap.org. More information on mosquito and sand fly vectors can be found at WRBUorg.

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Countries of West Africa

Background from the World Health Organization (WHO)

Benin
Burkina Faso
Cameroon
Cote d'Ivoire
Gambia
Ghana
Guinea
Guinea-Bissau
Liberia
Mali
Mauritania
Niger
Nigeria
Senegal
Sierra Leone
Togo

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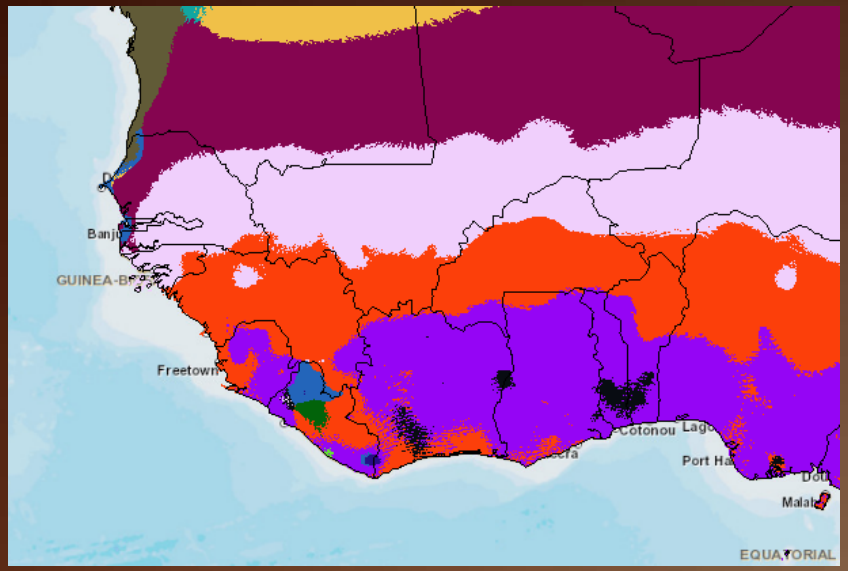
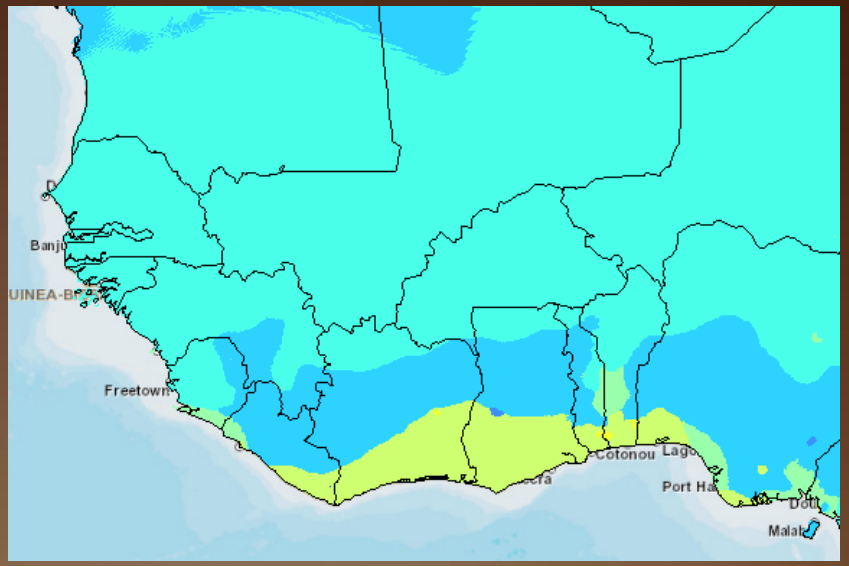
Climate of West Africa



1. Jan
2. Feb
3. Mar
4. Apr
5. May
6. Jun
7. Jul
8. Aug
9. Sep
10. Oct
11. Nov
12. Dec

Month of Maximum Precipitation -WorldClim



Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Month of Maximum Temperature -WorldClim

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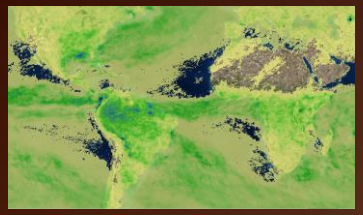
Monthly Climate Maps

Click here to view the maps described below



Rainfall

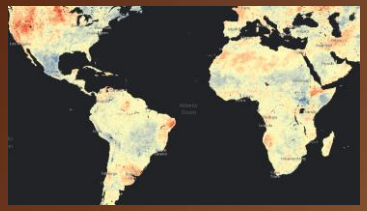
This map shows the accumulated rainfall for the past month. Updated monthly.
-NASA Earth Observations

Consistent Above and Below Average Precipitation

Areas with consistent above average monthly rainfall over the past 3 months may indicate increased mosquito breeding sites which may lead to increased mosquito-borne disease transmission. Areas with consistent below average rainfall may also indicate increased water storage or ponding which can provide additional habitat for mosquito species that lay eggs in human containers, protected micro environments, or long lasting pools. Updated monthly. -NASA Earth Observations.

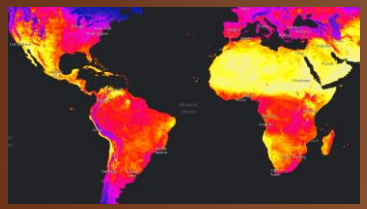
Drought Breaking Rain

Areas receiving above average rainfall for the past month and below average rainfall for the previous 12 months. Drought breaking rain may indicate recent suitable conditions for vectors and diseases in a stressed environment or human population. Updated monthly. -WorldClim, Giovanni online data system NASA GES DISC, Tropical Rainfall Measuring Mission (TRMM).



Temperature anomaly

This map shows where earth's temperatures were warmer or cooler in the daytime for the past month than the average temperatures for the same month from 2001-2010. Updated monthly.
-NASA Earth Observations



Land Surface Temperature

This map shows the temperature of the earth's lands during the daytime. Updated monthly.
-NASA Earth Observations

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Mosquito-borne Diseases

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Malaria

Malaria is a mosquito borne disease caused by parasites of the genus Plasmodium. It is primarily spread through the bite of mosquitoes of the genus Anopheles. Symptoms of malaria are flu-like including high fever and chills. According to the CDC there were an estimate 219 million cases of malaria world-wide in 2010 with approximately 91% of infections occurring in Africa (CDC, 2014).

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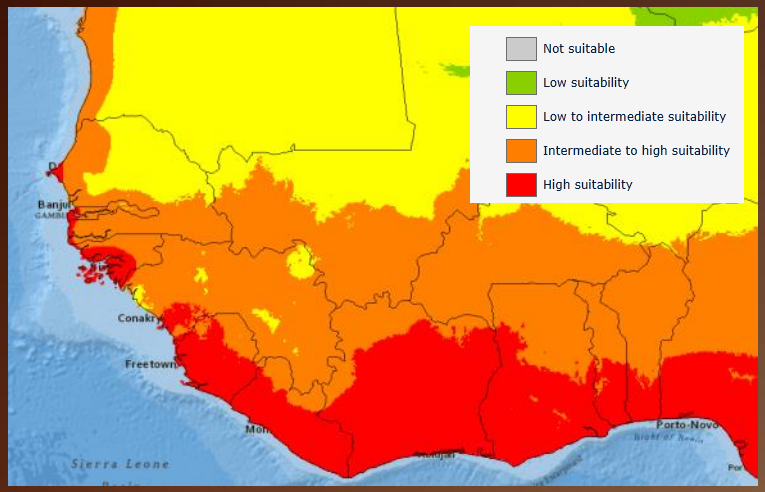
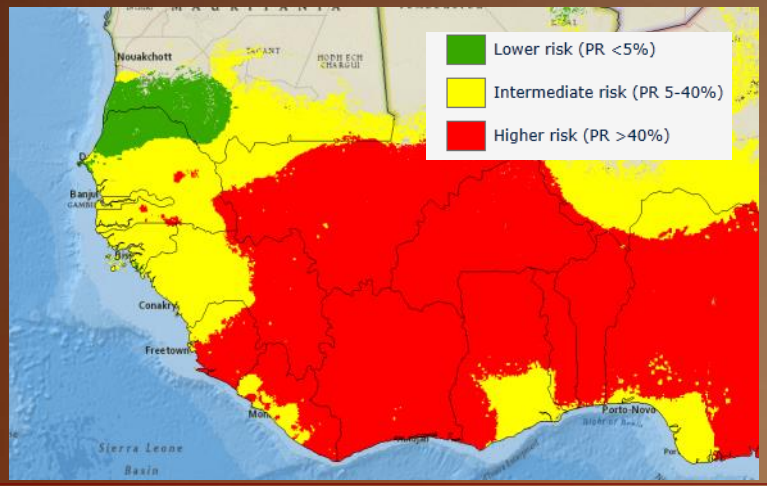
Malaria
(*Plasmodium falciparum*)

Temperature Suitability Index for *P. falciparum*
Gething et al. 2011



Number of months per year where mean temperatures can support infectious mosquito populations.
Gething, et al. 2011

Estimated proportion of children aged 2-10 years that are infected with P. falciparum. Averaged out over 12 months of 2010. Malaria Atlas Project



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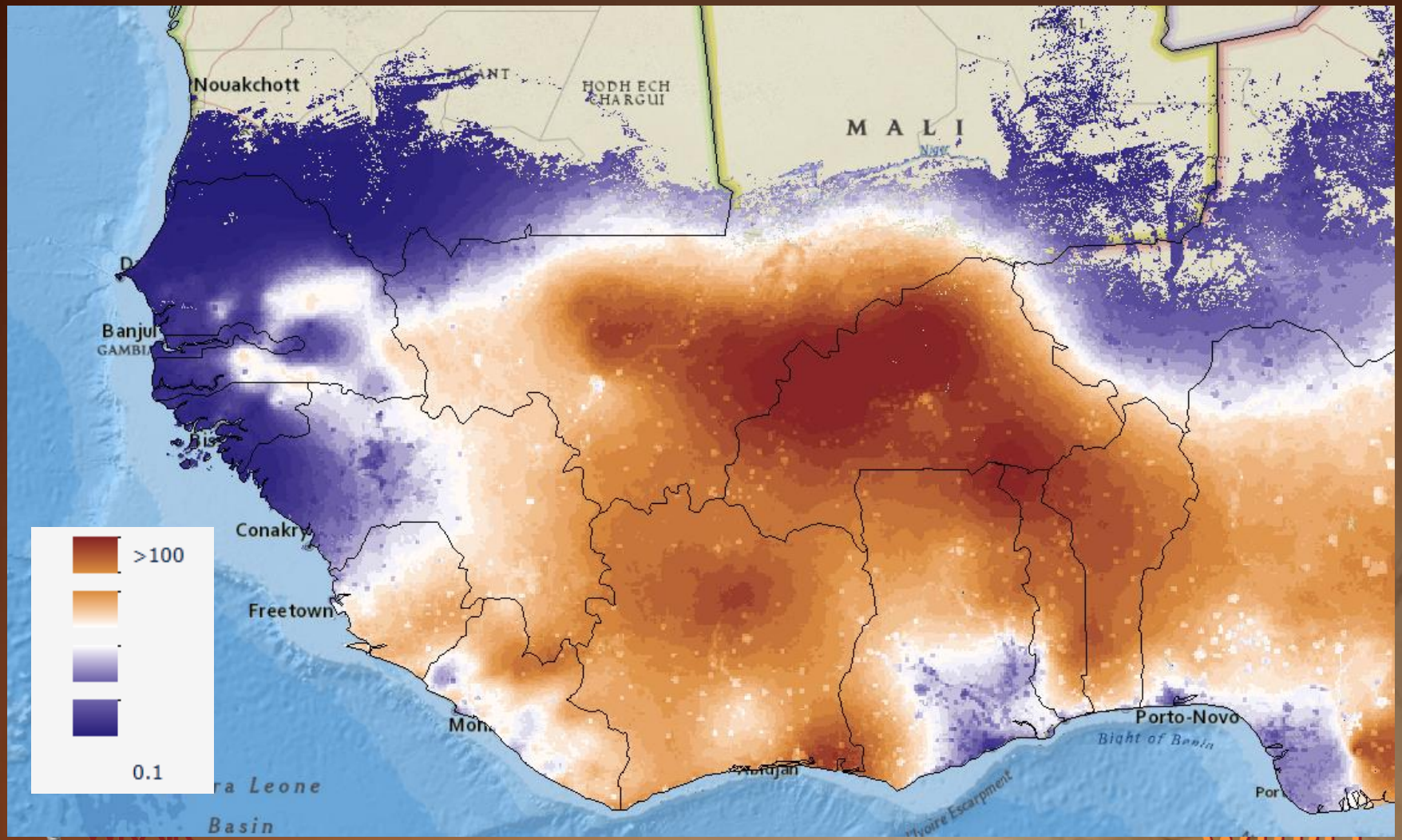
Malaria (*Plasmodium falciparum*)

Entomological Inoculation Rate, 2010. Number of expected bites from infected mosquitoes per person, per year.

-Gething et al. 2011



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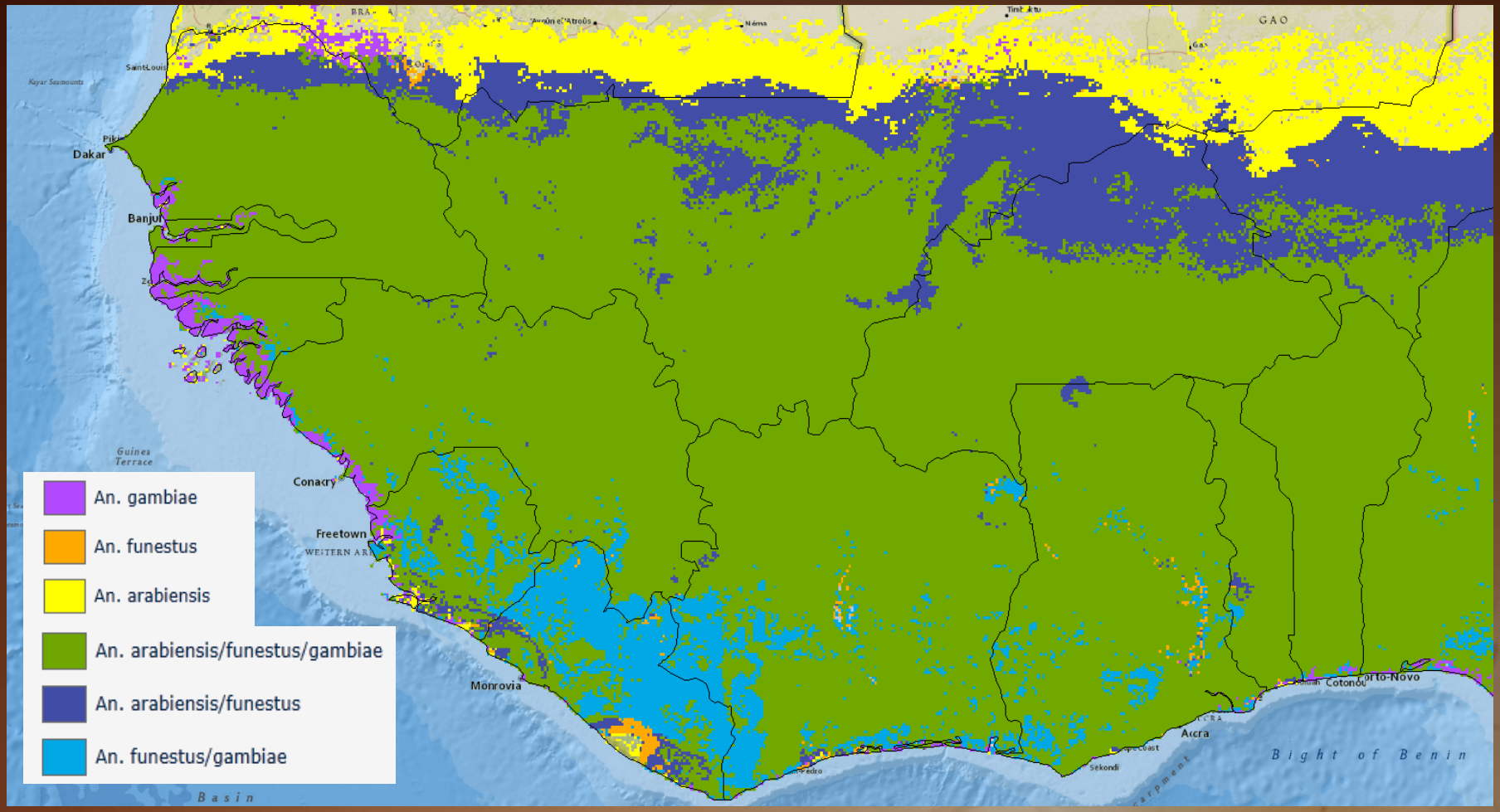
Dominant Malaria Vectors

-Malaria Atlas Project



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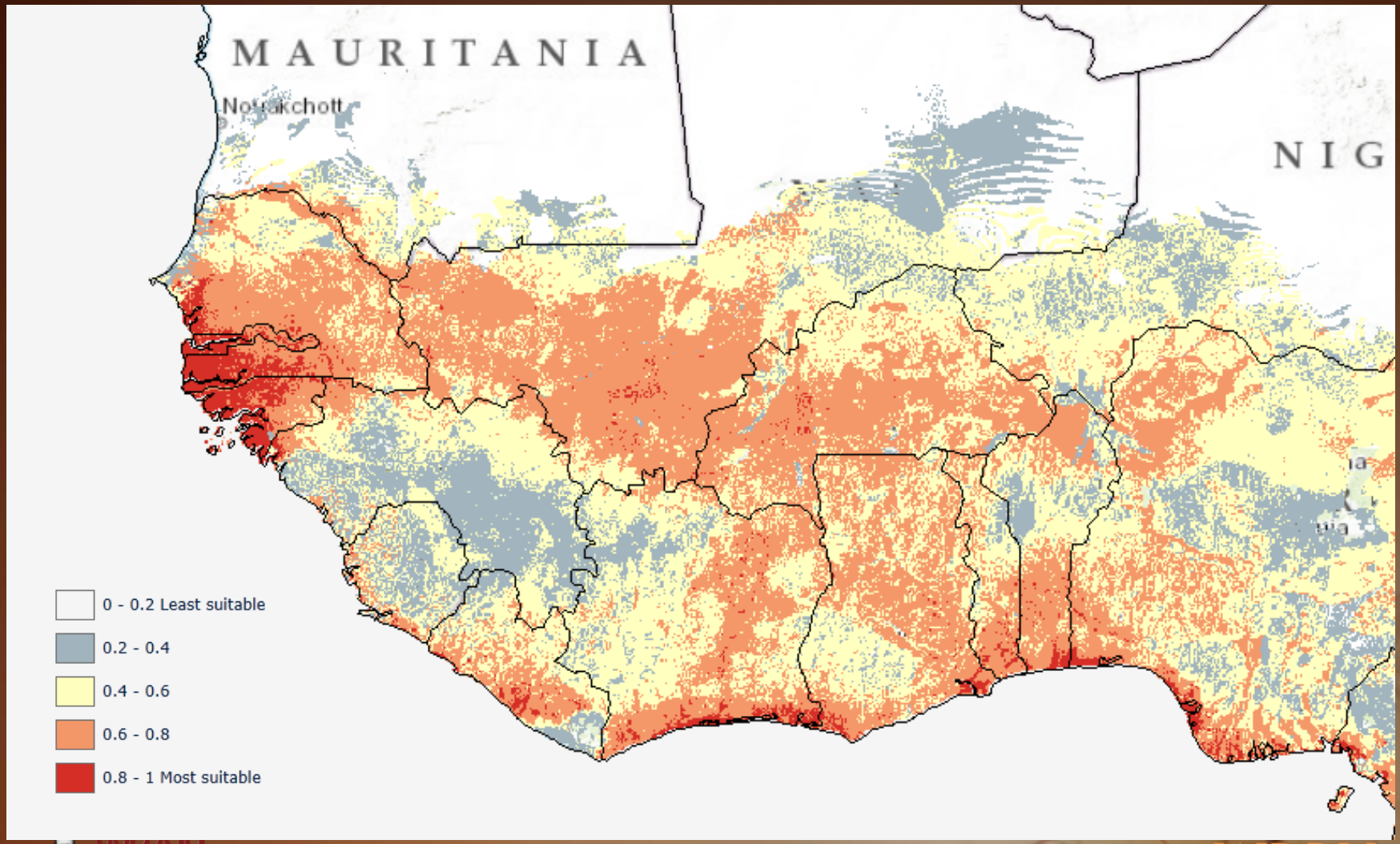
Habitat suitability model: *Anopheles gambiae* s.l.



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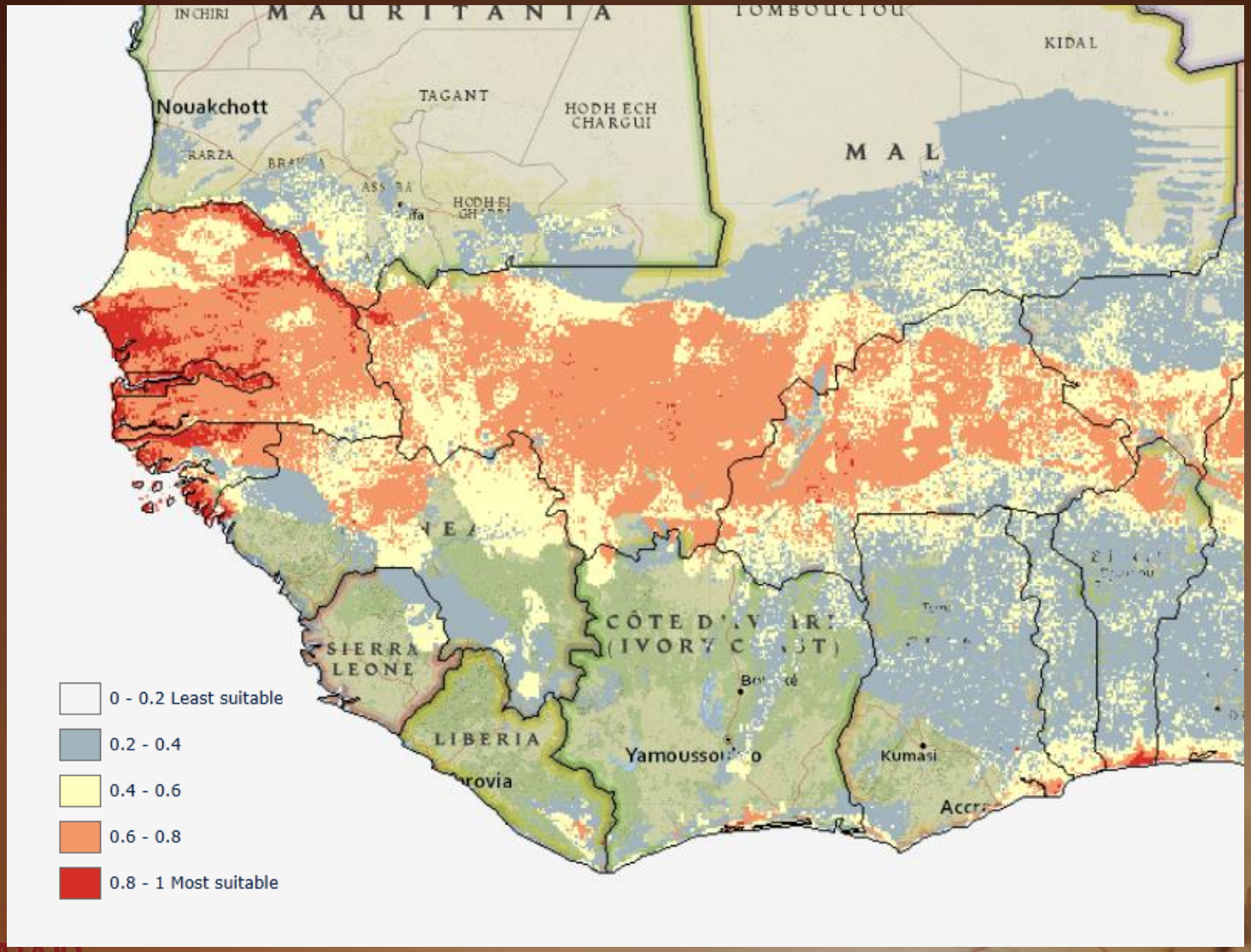
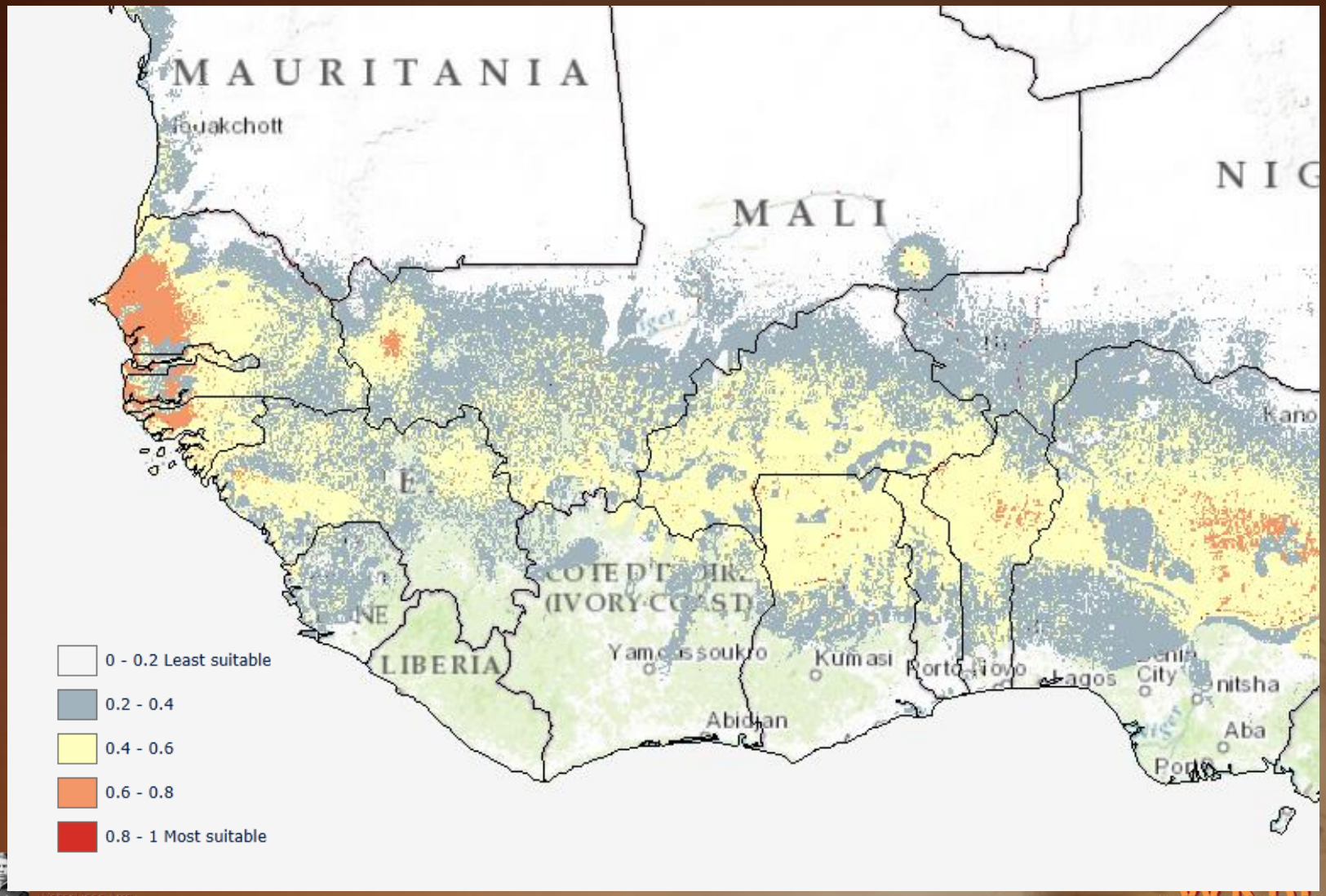
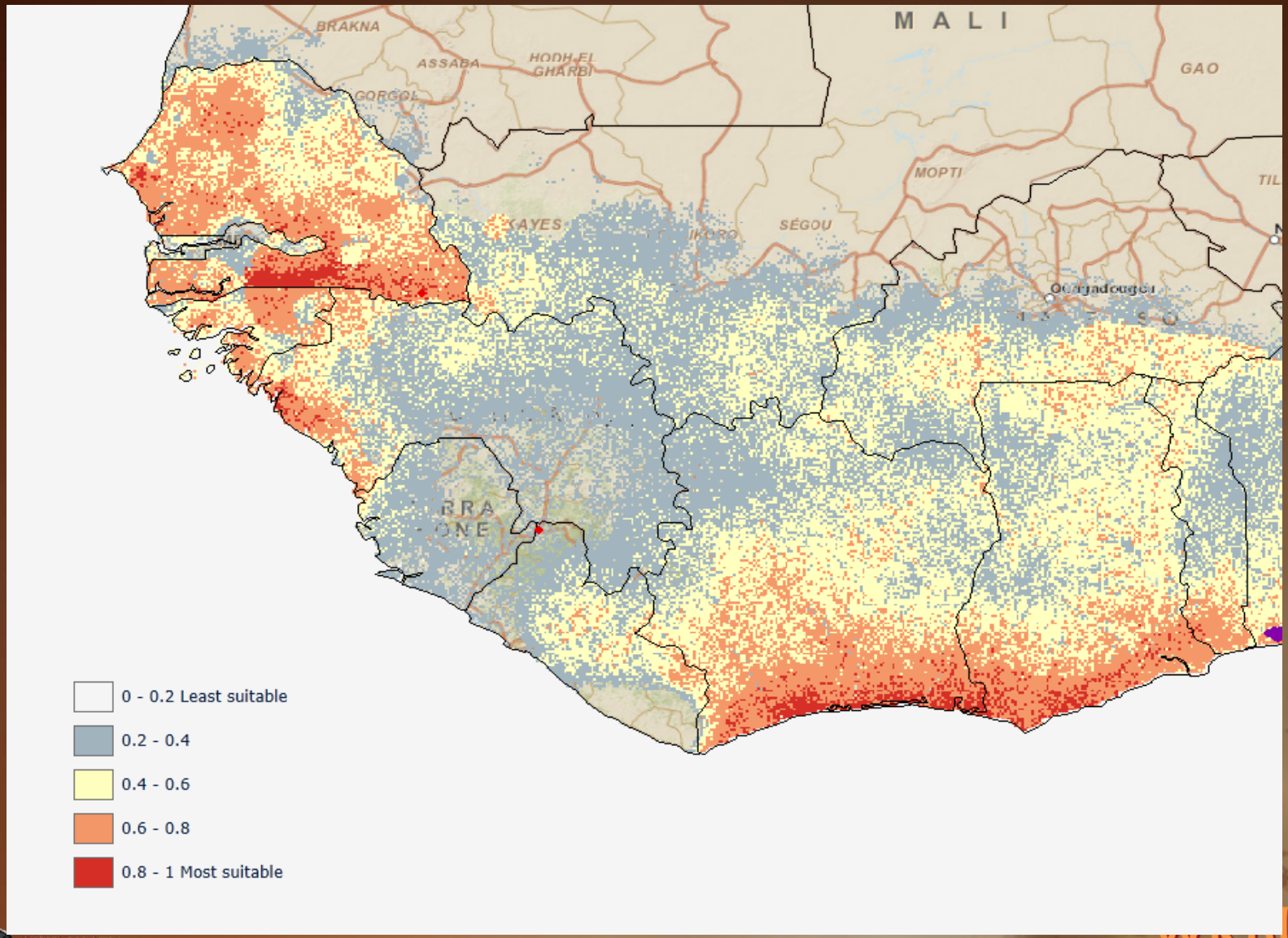
Habitat suitability model: *Anopheles arabiensis*



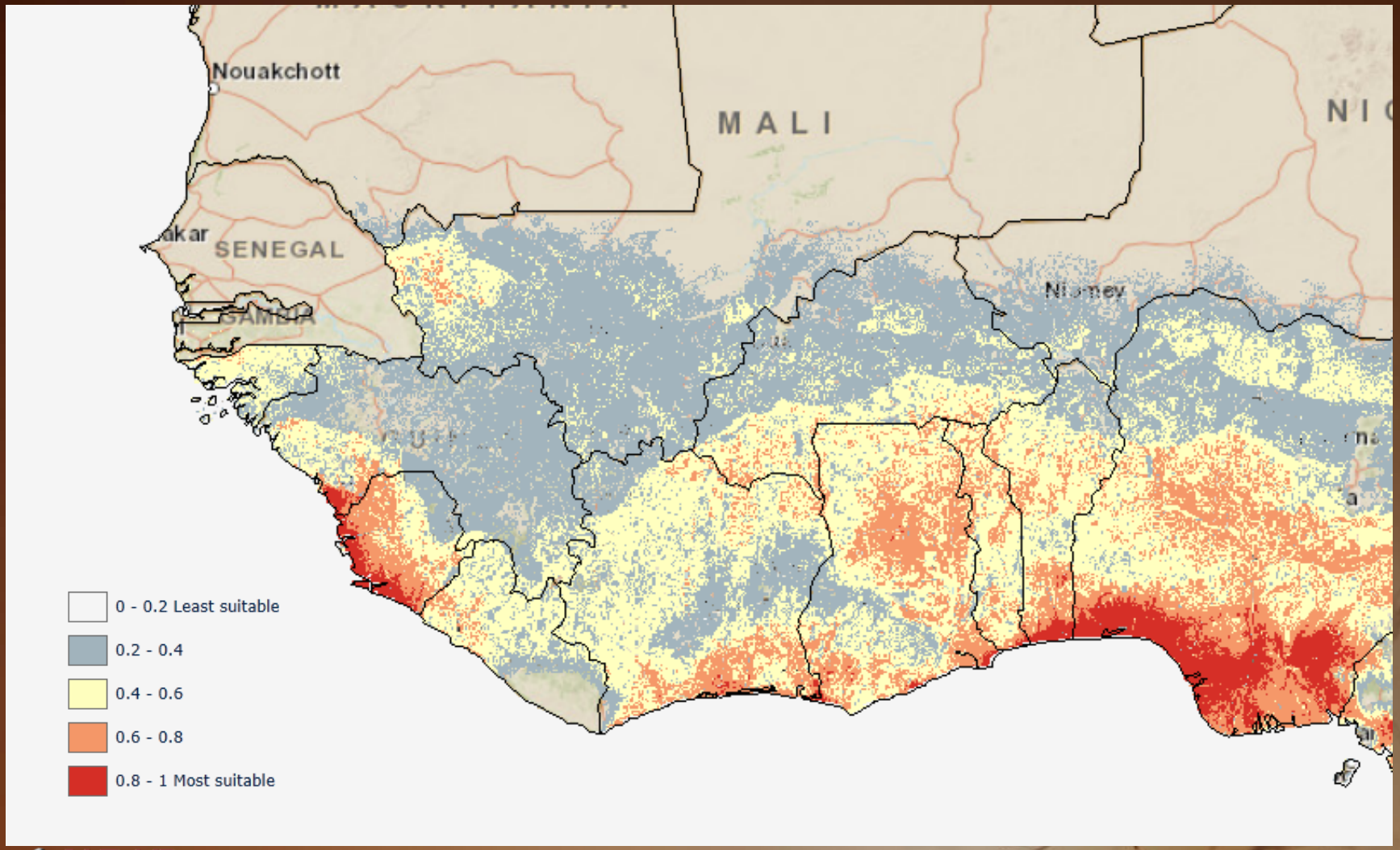
Habitat suitability model: *Anopheles wellcomei*



Habitat suitability model: *Anopheles funestus*



Habitat suitability model: *Anopheles nili*



Anopheles (Cel.) gambiae Giles, 1902

Bionomics:
This species occurs in a great variety of types of water; the most striking are the shallow, open sun-lit pools. Females readily enter houses and bite man both indoors and outdoors starting at sunset and peaking just at dawn (Gillies and deMeillon 1968).

Medical Importance:
Primary malaria vector (Gillies and deMeillon 1968).

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Note:
An. gambiae and An. arabiensis are morphologically identical and can only be differentiated using molecular techniques

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Anopheles (Cel.) arabiensis Patton, 1905

Bionomics:

An. arabiensis larvae are found in relative short duration habitats (3-5 weeks) with high turbidity and lacking in aquatic vegitation or surface film. Chosen breeding sites appear to be associated with cattle, the preferred host. (Gimnig, Ombok, Kamau and Hawley 2001:286)

Medical Importance:

Primary malaria vector (Gillies and deMeillon 1968).

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Note:
An. gambiae and An. arabiensis are morphologically identical and can only be differentiated using molecular techniques

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Anopheles (Cel.) wellcomei Theobald, 1904

Bionomics:
Larvae are found in swamps with vertical and horizontal vegetation, streams with grassy margins, rice fields and vegetation along large rivers even in areas of high forest. Females will enter houses to bite but are mainly zoophilic. Biting activity begins at dusk and peaks at about 2300, after which it gradually decreases (Gillies and deMeillon 1968).

Medical Importance:
Possible malaria vector (Gillies and deMeillon 1968).

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Anopheles (Cel.) funestus Giles, 1900

Bionomics:

In most parts of its range, *An. funestus* breeds characteristically in bodies of clear water that are either large and more or less permanent, e.g. swamps (near edges if deep), weedy sides of streams, rivers, furrows or ditches, protected portions of lake shore, ponds, etc., especially when weedy, or water such as seepages, which are fed from underground permanent sources (Evans 1938). A. funestus is one of the most anthropophilic mosquitoes known. The great bulk of feeding takes place inside houses after 2200 up to dawn (Gillies and deMeillon 1968).

Medical Importance:

Vector of malaria and bancroftian filariasis (Gillies and deMeillon 1968).

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Anopheles (Cel.) nili (Theobald, 1904)

Bionomics:

Principally a stream breeder, larvae being found in vegetation or in dense shade along the edges of streams and large rivers. Symes (1931a) found that out of 163 collections of larvae of this species in Kenya, 139 were taken from streams. Variable in behaviour in both feeding and resting habits. In Liberia, Barber et al. (1932), Sierra Leone, Gordon et al. (1932)) Upper Volta, Hamon, Choumara et al. (1959), Dahomey, Hamon, Rickenbach and Robert (1956)) Nigeria, Service (1963a), Cameroun, Hamon and Mouchet (1961), Chad, Lacan (1958), and in parts of the Sudan, Lewis (1956a), it is an anthropophilic species biting man readily indoors and outdoors and frequently resting indoors by day. It has also been recorded as quite common in houses in the West Nile district of Uganda, Kafuko et al. (1962). (Gilies and deMeillon 1968:85)

Medical Importance:

An important malaria vector in many parts of West Africa. Wherever man-biting occurs infected specimens are found. (Gilies and deMeillon 1968:85)

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Dengue Fever and Chikungunya virus

According to the CDC, dengue fever is the leading cause of illness in the tropics and sub-tropics. Dengue fever is caused by a group of viruses Symptoms of Dengue include high fever, severe headache and joint pain (CDC, 2014).

Chikungunya (pronounced: \chik-en-gun-ye) virus (CHIKV) is transmitted to humans by mosquitoes of the genus Aedes. The most common symptoms of chikungunya virus infection are fever and joint pain. Other symptoms may include headache, muscle pain, joint swelling, or rash (CDC, 2014).

Currently, there is no vaccine to prevent or medicine to treat dengue and chikungunya viruses.

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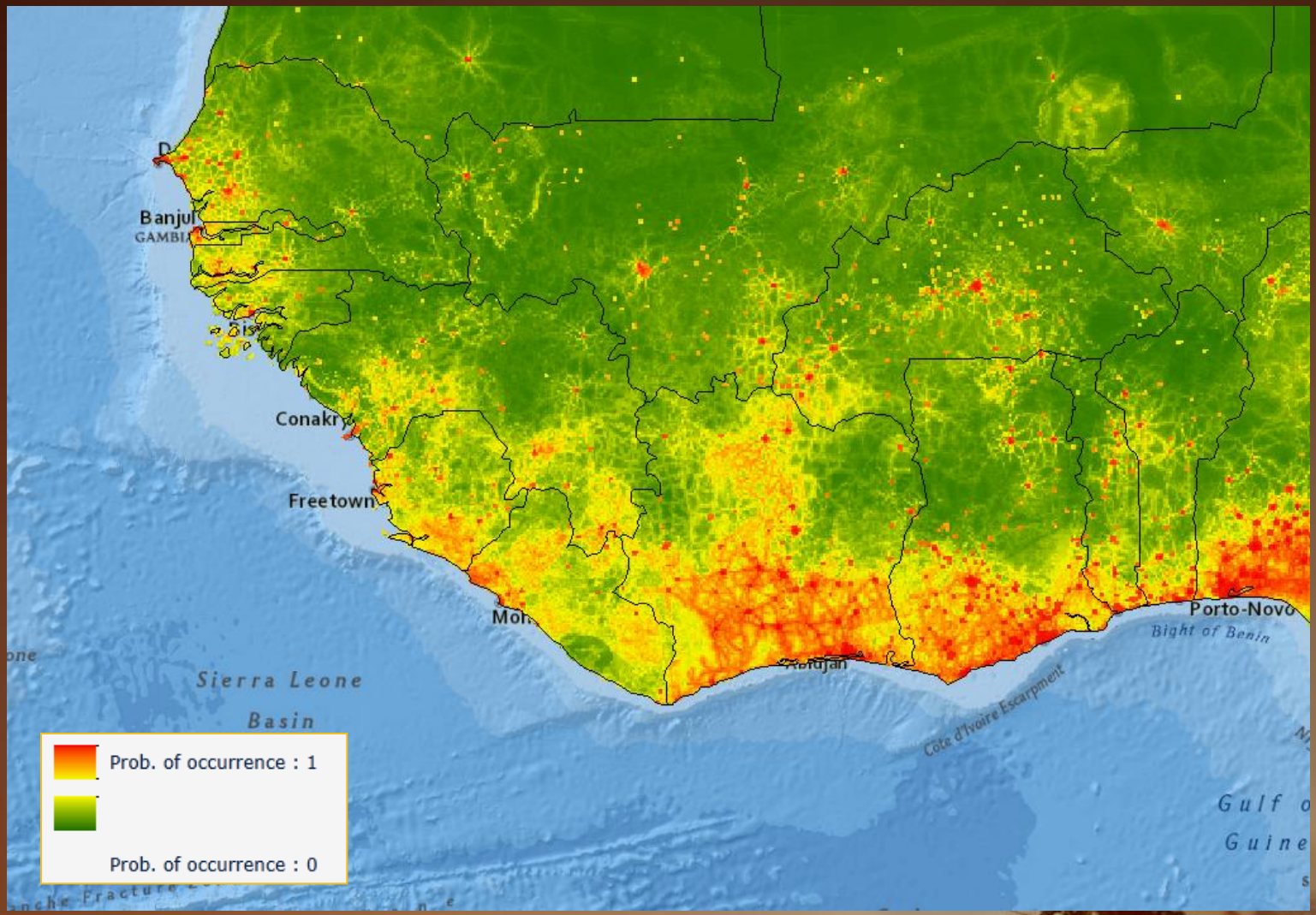
Dengue Virus Prediction Model

Bhatt, S. et al. 2013



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Countries reporting CHIKV cases to CDC as of March 2015

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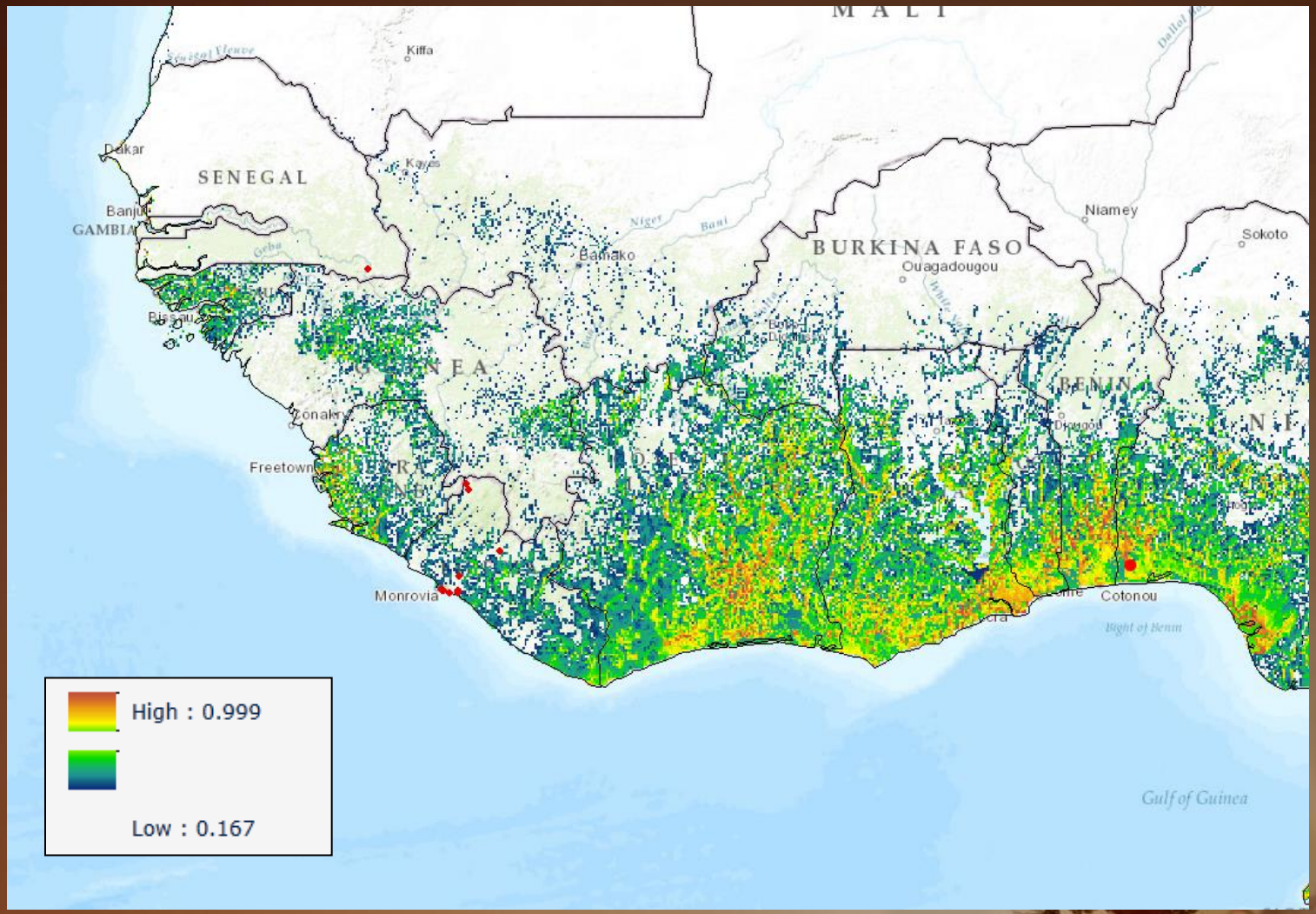
Habitat suitability model: *Aedes aegypti*



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Primary Vectors of CHIKV

Aedes (Stg.) aegypti (Linnaeus, 1762)

“Yellow Fever Mosquito”

Bionomics:

In association with man, *Ae. aegypti* will use any and all natural and artificial containers. Away from urban areas the species tends to favor pools in river beds, tree stumps, tree holes and natural containers. Females are primarily day biters and readily enter buildings to feed. They have also been taken in lesser numbers at night (Christophers 1960).

Medical Importance:

This species is a primary vector of dengue, chikungunya virus and yellow fever (Christophers 1960).

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Yellow Fever

Yellow fever is a mosquito borne disease caused by an RNA virus of the genus Flavivirus. It is spread by mosquitoes feeding on infected human or non-human primates. In West Africa, the yellow fever virus is primarily spread by mosquitoes of the genus Aedes. A yellow fever vaccine has been developed and is recommended for anyone traveling to areas where the disease is commonly transmitted.

(CDC, 2014).

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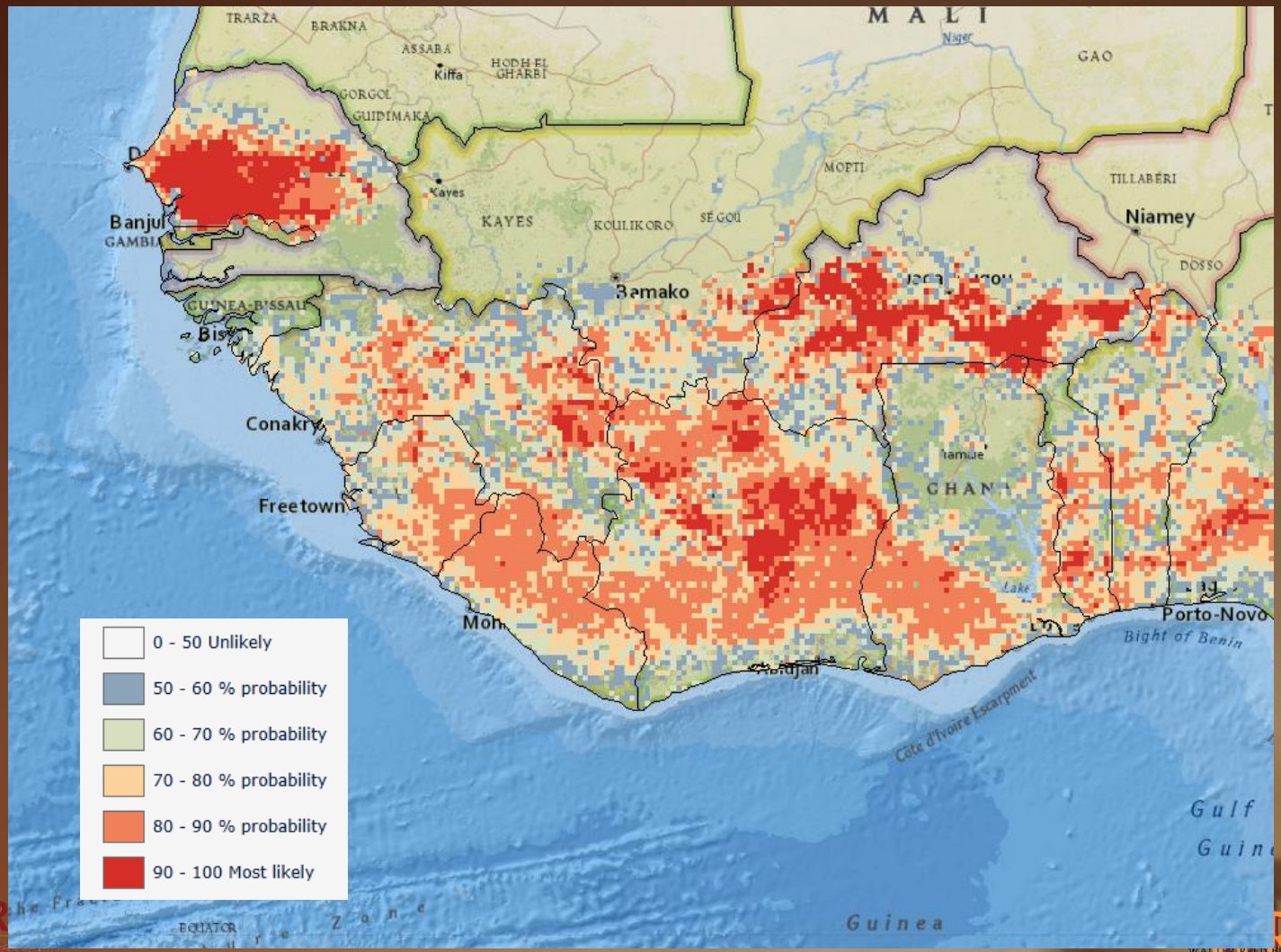
Predicted Probability of Occurrence of Yellow Fever

-University of Oxford, 2006



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Countries Reporting Yellow Fever

-CDC, 2010

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Rift Valley Fever

Rift Valley fever is a mosquito borne illness caused by a virus of the genus Phlebovirus and is most commonly found in livestock but can also be transmitted to humans. Symptoms of RVF include mild illness, general pain and dizziness. RVF is most commonly found in Africa, however outbreaks have occurred in the middle East as well (CDC, 2014).

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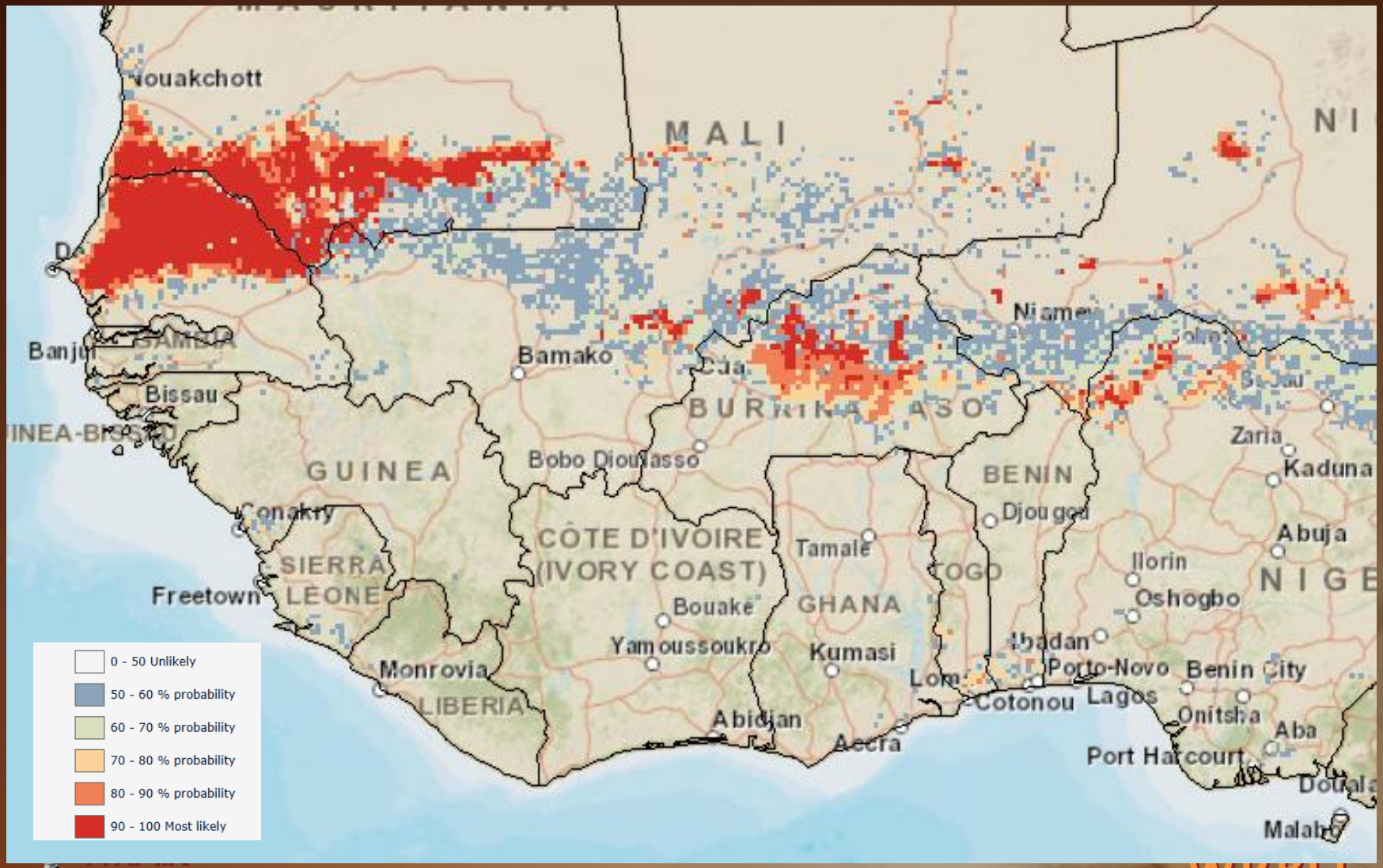
Rift Valley Fever Prediction Model

University of Oxford, 2006



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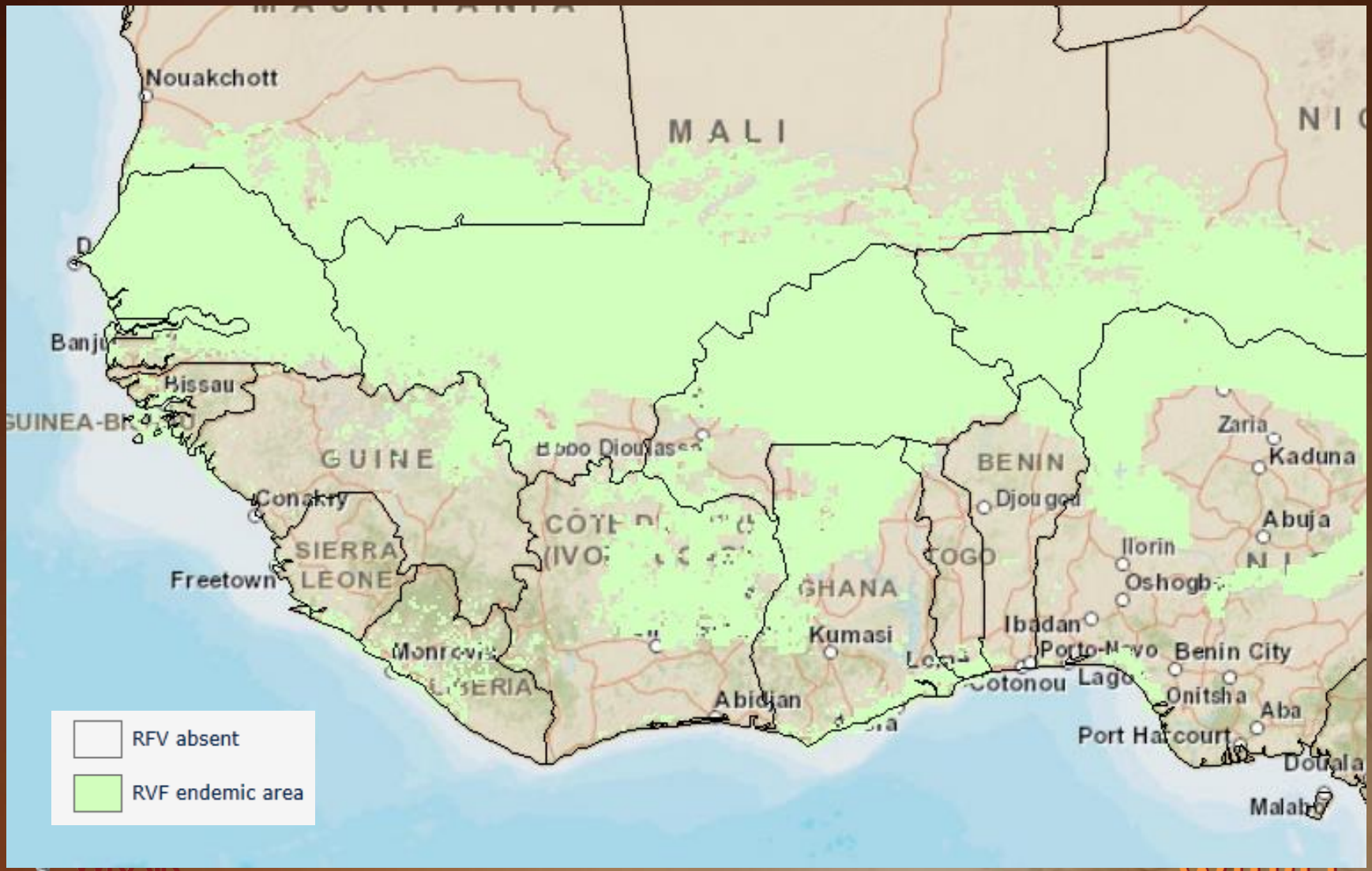
Rift Valley Fever Virus: Endemic Areas

-DoD-GEIS



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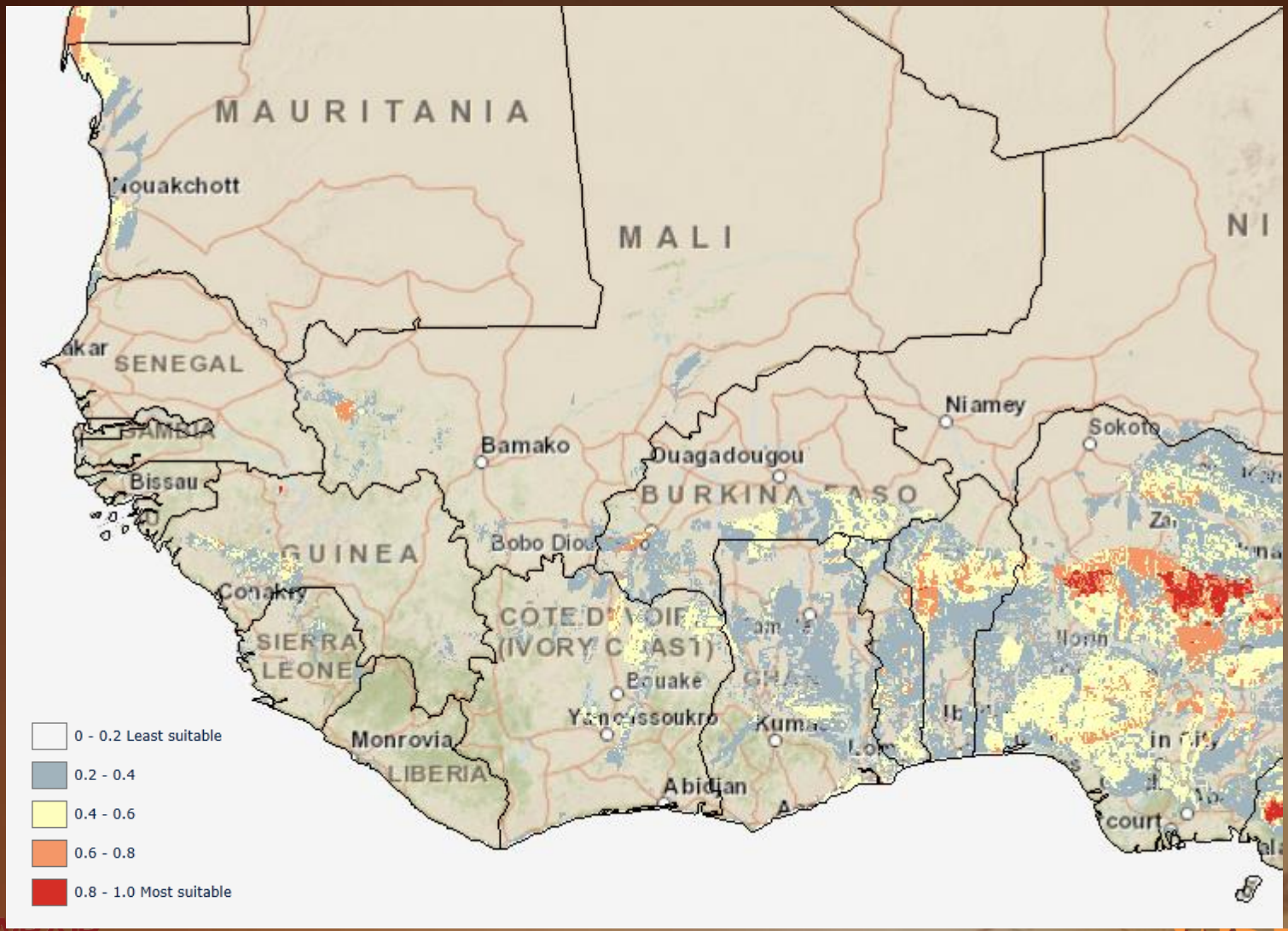
Habitat suitability model: *Culex pipiens*



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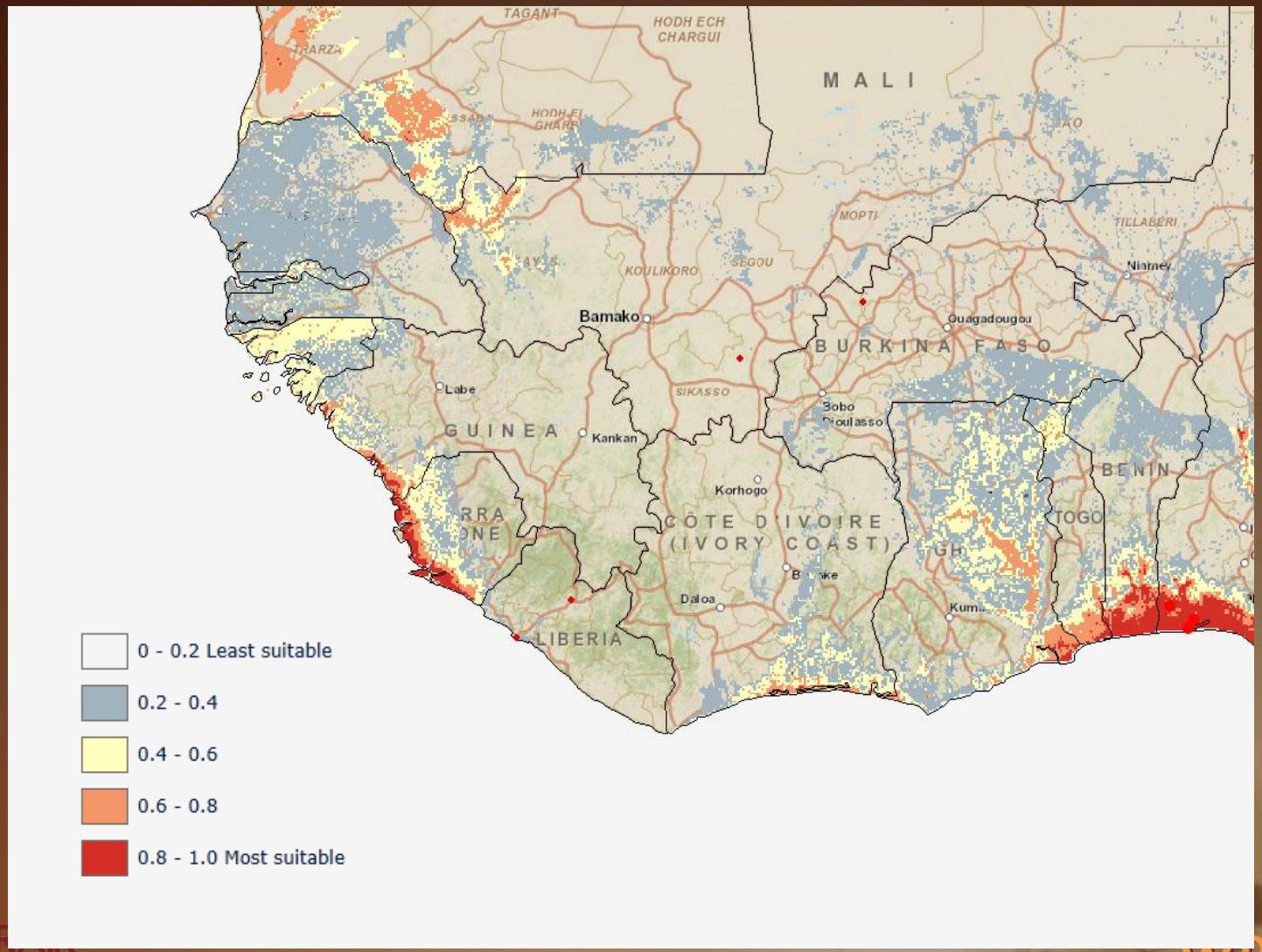
Habitat suitability model: *Culex antennatus*



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Culex (Cux.) pipiens Linnaeus, 1758

Bionomics:

Larvae are found in numerous and variable breeding places ranging from highly polluted cesspits to clear water pools and containers. This species usually breeds in stagnant water in either shaded or unshaded situations. Females readily attack man both indoors and outdoors (Harbach 1988).

Medical Importance:

It has been found naturally infected with Sindbis virus and West Nile viruses in Israel, West Nile and Rift Valley Fever in Egypt, and is a primary vector of periodic Bancroftian filariasis (Harbach 1988).

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Culex (Cux.) antennatus (Becker, 1902)

Bionomics:
Larvae are commonly found in stagnant fresh ground water habitats that include rice fields, stream pools, springs, ponds, swamps, ditches, seepages and animal footprints. Females are evening biters, feeding primarily on cattle, but entering houses to bite man (Harbach 1988).

Medical Importance:
Vector of West Nile virus and Rift Valley Fever (Harbach 1988).

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References

Part 1: Mosquitoes:

Maxent model of Ae. aegypti habitat suitability, Nyari, A.

Maxent model of Ae. arabiensis habitat suitability, Nyari, A. July 2011.

Maxent model of An. gambiae habitat suitability, Nyari, A. 2011.

Maxent model of An. funestus habitat suitability, Dornak, L. September, 2011.

Maxent model of An. nili habitat suitability, Nyari, A. June, 2011.

Maxent model of An. wellcomei habitat suitability, Dornak, L. June, 2012.

Maxent model of Cx. antennatus habitat suitability, Nyari, A. June 2011.

Maxent model of Cx. pipiens habitat suitability, Dornak, L. September, 2011.

- Gething, Peter W. et al. A new world malaria map: Plasmodium falciparum endemicity in 2010. Malaria Journal 2011, 10:378.
- Bhatt, S. et al. 2013. The Global Distribution and Burden of Dengue. Natrure, 496: 504-507.
- Predicted Probability of Occurrence of Yellow Fever Virus. Spatial Ecology and Epidemiology Research Group, University of Oxford, Dept. of Zoology. Models for vectors and vector-borne diseases. Advances in Parasitology 62, 1 – 35. 2006.
- Predicted Probability of Occurrence of Rift Valley Fever Virus. Spatial Ecology and Epidemiology Research Group, University of Oxford, Dept. of Zoology. Advances in Parasitology 62, 1 – 35. 2006.
- Predicted Probability of Occurrence of Japanese Encephalitis Virus. Spatial Ecology and Epidemiology Research Group, University of Oxford, Dept. of Zoology. Advances in Parasitology 62, 1 – 35. 2006.
- Areas indicated are those within an RVF endemic region or in areas where RVF virus has previously been identified. DoD-GEIS & NASA/GSFC Project leader: Asaph Anyamba, from the DoD-GEIS Web RVF page

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The Walter Reed Biosystematics Unit is part of the Walter Reed Army Institute of Research and is based at the Smithsonian Institution Museum Support Center. To access taxonomic keys, the Systematic Catalog of Culicidae or to learn more about WRBU visit www.wrbu.org.

Vector Photos Courtesy of Judith Stoffer, Walter Reed Biosystematics Unit

VECTORMAP

VectorMap is only as good as the data you provide. If you have collection records, models or pathogen testing results please contact the VectorMap team to learn how to contribute data at mosquitomap@si.edu.

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