Vector Hazard Report:
Mosquito-Borne Diseases of The Middle East

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

Systematic Catalogue of the Culicidae
VectorMap

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Table of Contents

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Background

Vector-borne disease hazards in the middle east include malaria, dengue fever, chikungunya virus, West Nile virus, leishmaniasis and Crimean-Congo hemorrhagic fever. This brief identifies factors that can impact disease risk including climate anomalies, vector distributions and host densities. All maps are available for download on VectorMap.org. More information on mosquito and sand fly vectors can be found at wrbu.org.

Back to Table of Contents

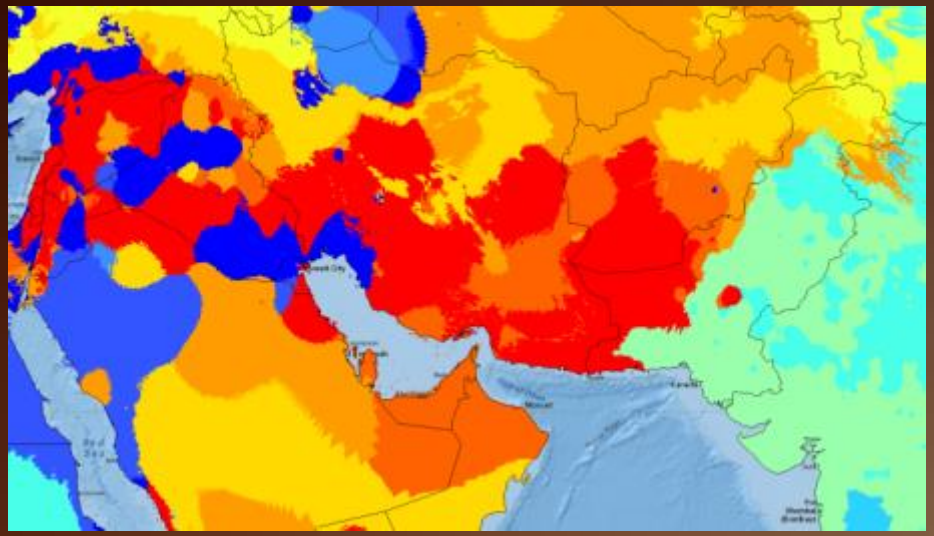
Countries of the Middle East

Background from the World Health Organization (WHO)

Afghanistan
Bahrain
Iran
Iraq
Israel
Jordan
Lebanon
Oman
Pakistan
Qatar
Saudi Arabia
United Arab Emirates

Back to Table of Contents

Climate of the Middle East



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

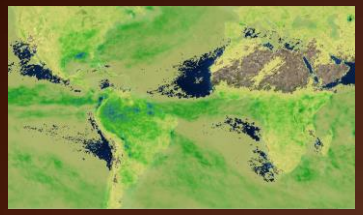
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Month of Maximum Temperature -WorldClim

Back to Table of Contents

Monthly Climate Maps

Click here to view the maps described below



Rainfall

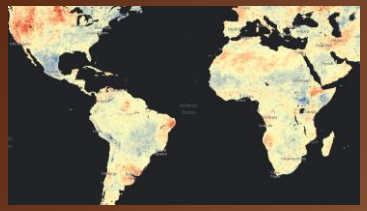
This map shows the accumulated rainfall for the past month. Updated monthly.
-NASA Earth Observations

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.

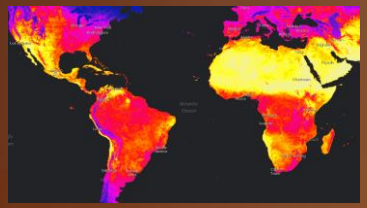
Drought Breaking Rain

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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Back to Table of Contents

WRBU

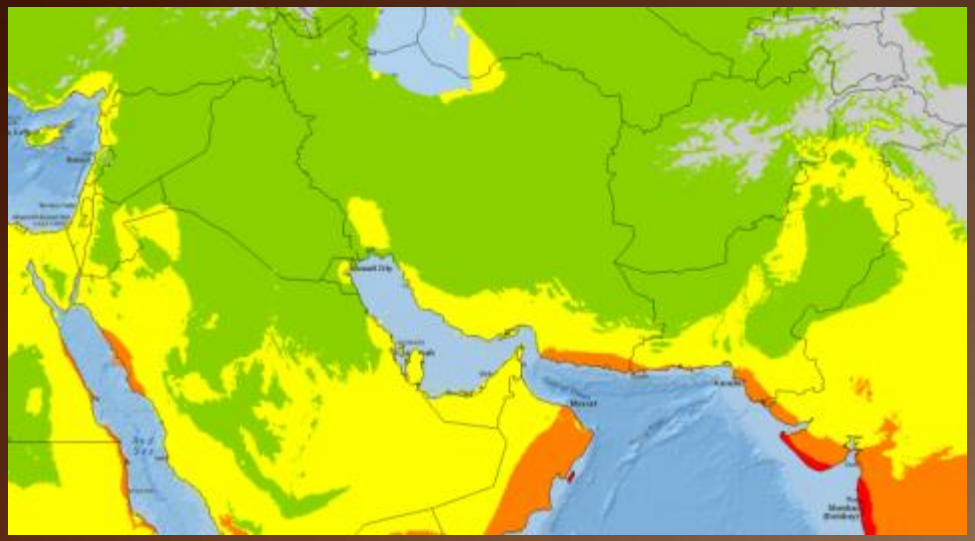
Malaria

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).

The World Health Organization (WHO) reports that about half the world's population is at risk of malaria infection. Although there is no current vaccine for malaria, the disease is preventable and treatable (WHO, 2014).

Back to Table of Contents

Plasmodium falciparum



The normalized Z(T) index of temperature suitability that incorporates the duration and degree of suitability across an average year
-Gething et al. 2011

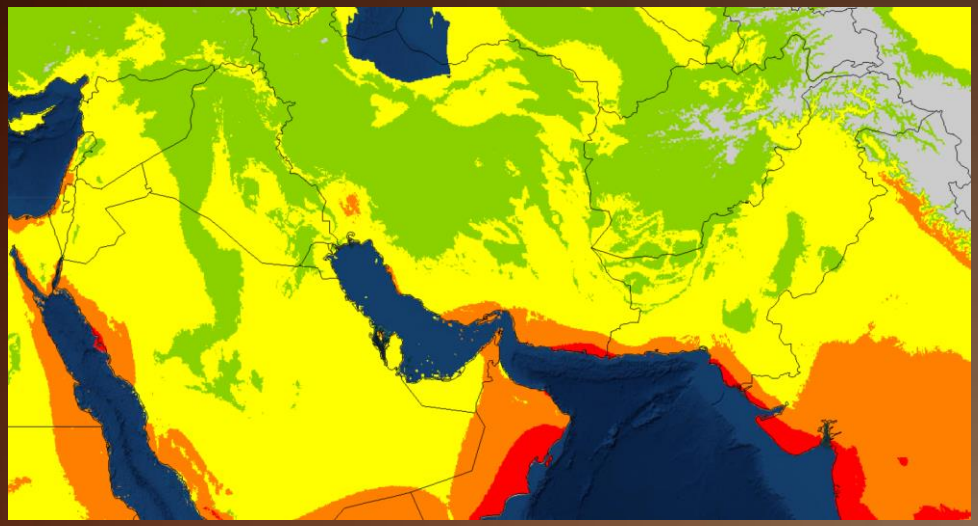
- Not suitable
- Low suitability
- Low to intermediate suitability
- Intermediate to high suitability
- High suitability

Stratified estimate proportion of 2-10 year olds in the general population that are infected with P. falciparum at any one time averaged over the 12 months of 2010.
-Malaria Atlas Project

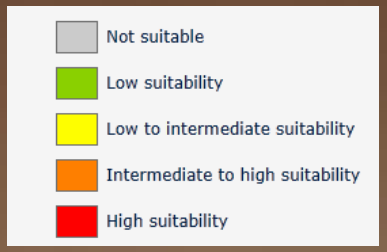
- Lower risk (PR <5%)
- Intermediate risk (PR 5-40%)
- Higher risk (PR >40%)

Back to Table of Contents

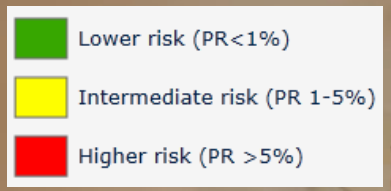
Plasmodium vivax



The normalized Z(T) index of temperature suitability that incorporates the duration and degree of suitability across an average year
-Gething et al. 2011

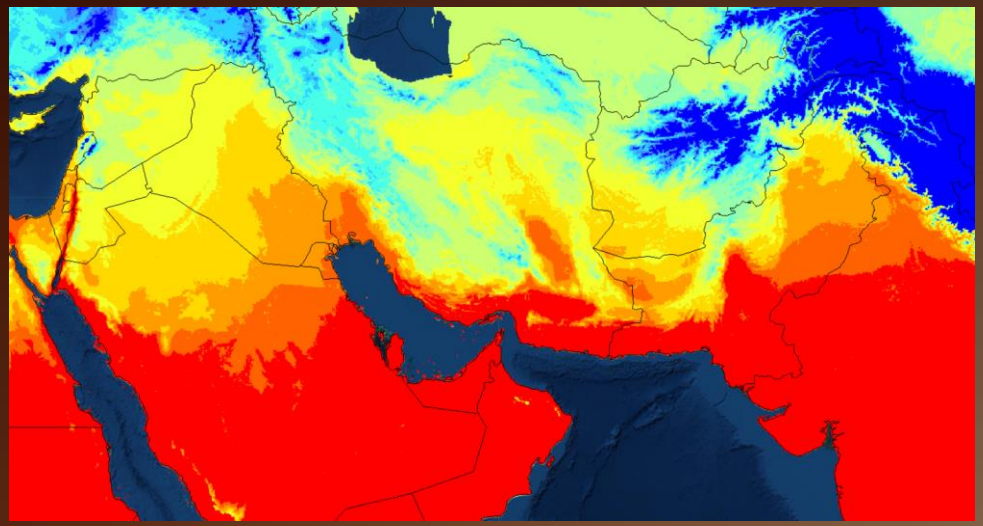


Stratified estimate proportion of the general population that are infected with P. vivax at any one time averaged over the 12 months of 2010.
-Malaria Atlas Project

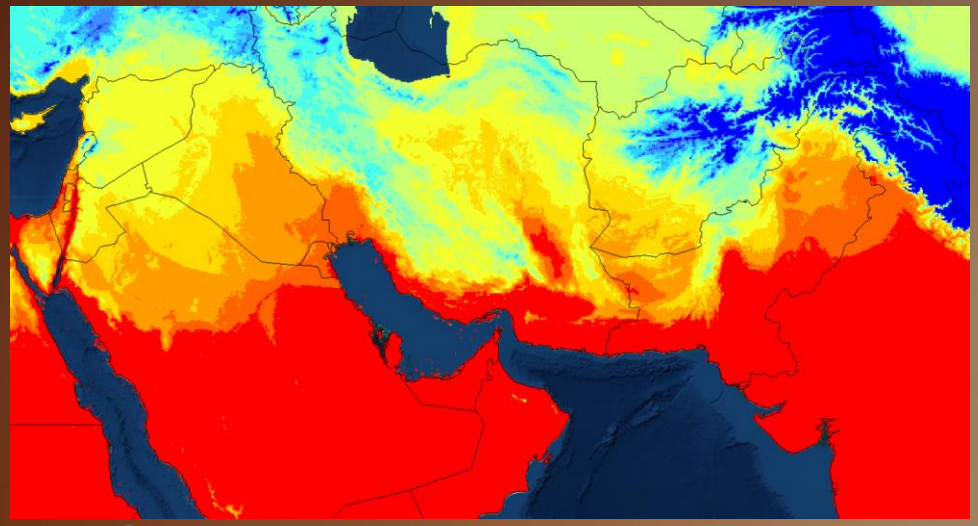


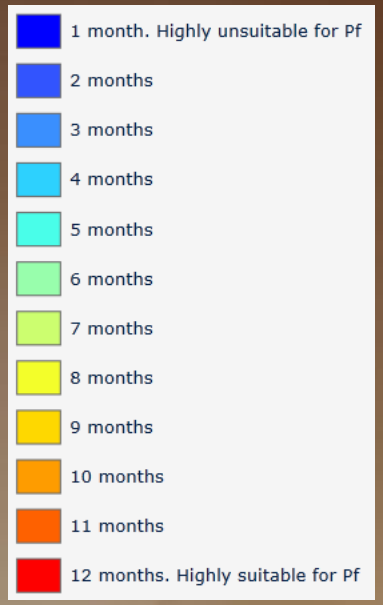
Back to Table of Contents

Infectious Days



The number of days in an average year (grouped by month), in which the annual temperature regime could support potentially infectious vectors of *P. falciparum*.
-Gething et al. 2011



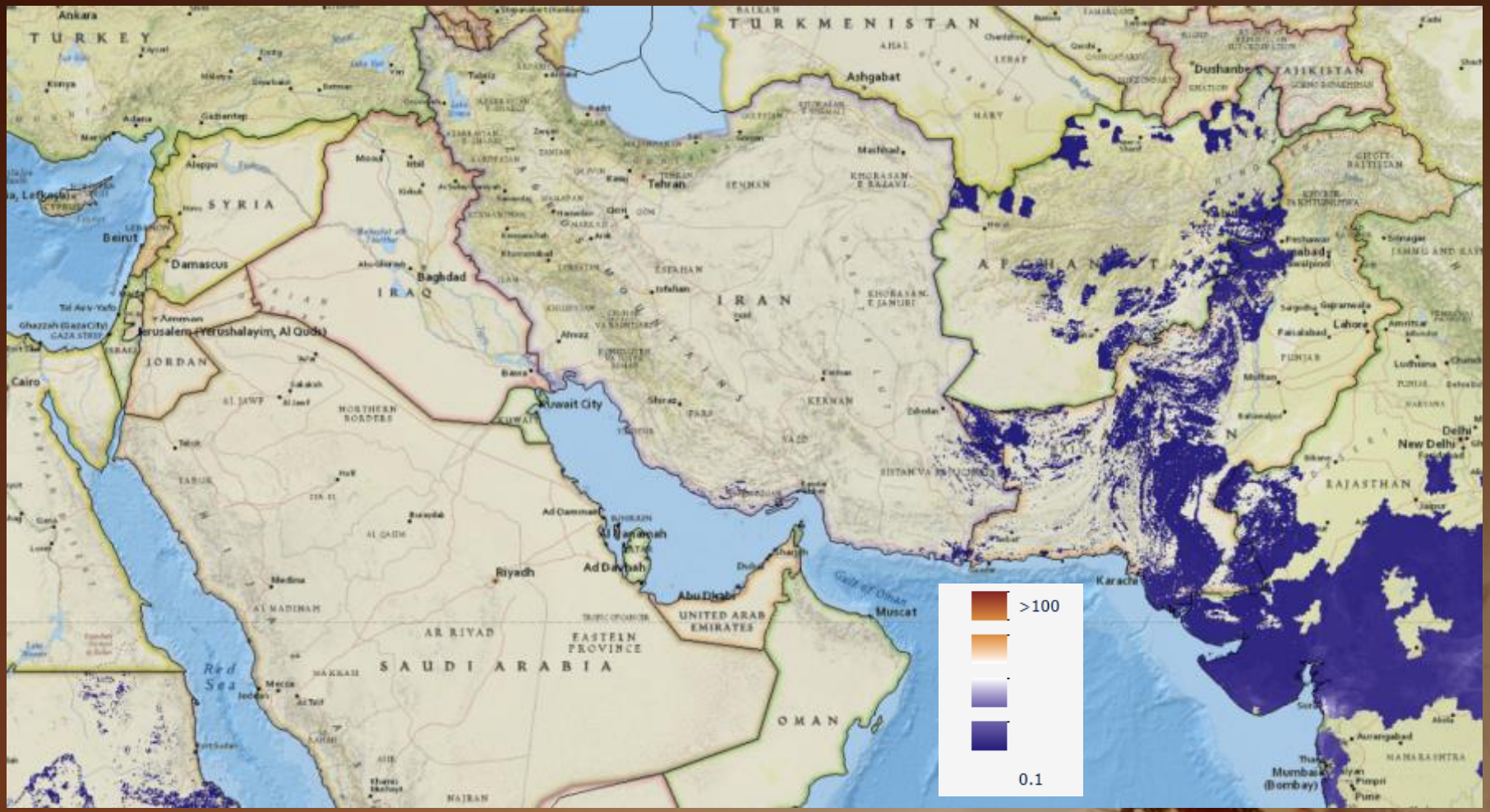


The number of days in an average year (grouped by month), in which the annual temperature regime could support potentially infectious vectors of *P. vivax*.
-Gething et al. 2011

Back to Table of Contents

Malaria (Plasmodium falciparum) Entomological Inoculation Rate, 2010

Number of expected bites
from infected mosquitoes per person, per year.
-Gething et al. 2011



Back to Table of Contents

Malaria (*Plasmodium vivax*) Estimated proportion of population infected with P. vivax, 2010

-Malaria Atlas Project

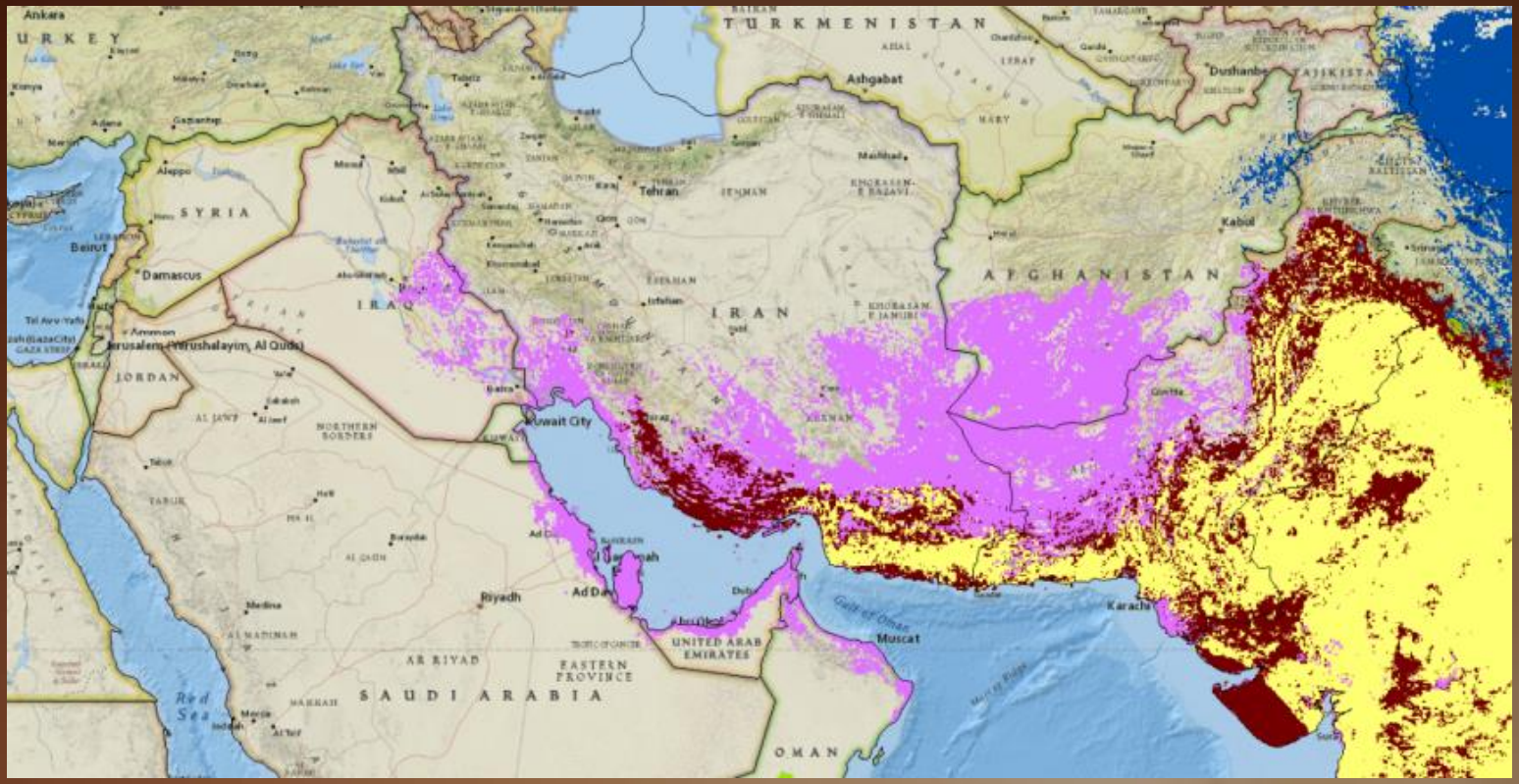
Back to Table of Contents

Malaria Vectors:
Habitat Suitability Models

Back to Table of Contents

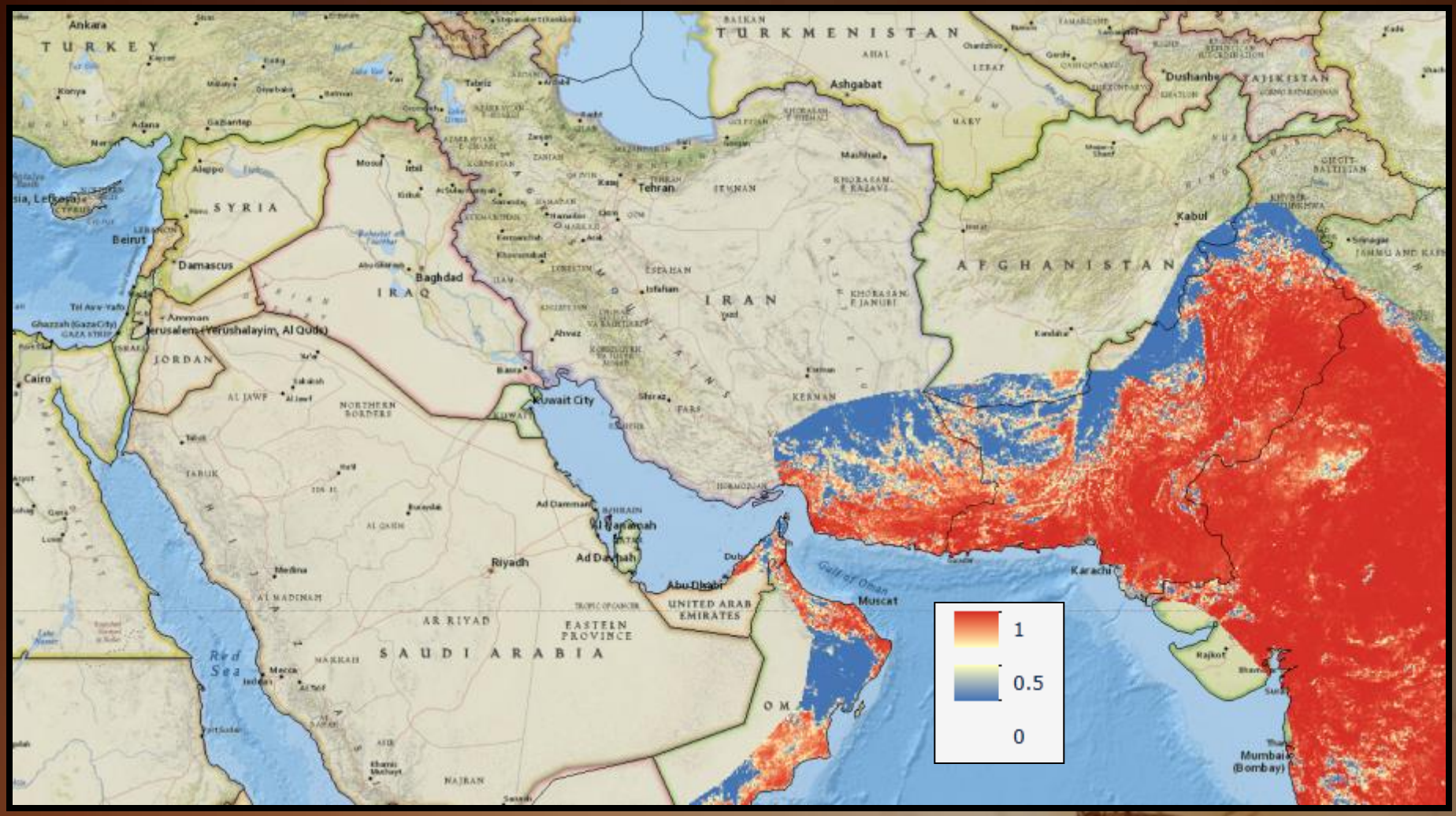
Dominant Malaria Vectors

-Malaria Atlas Project



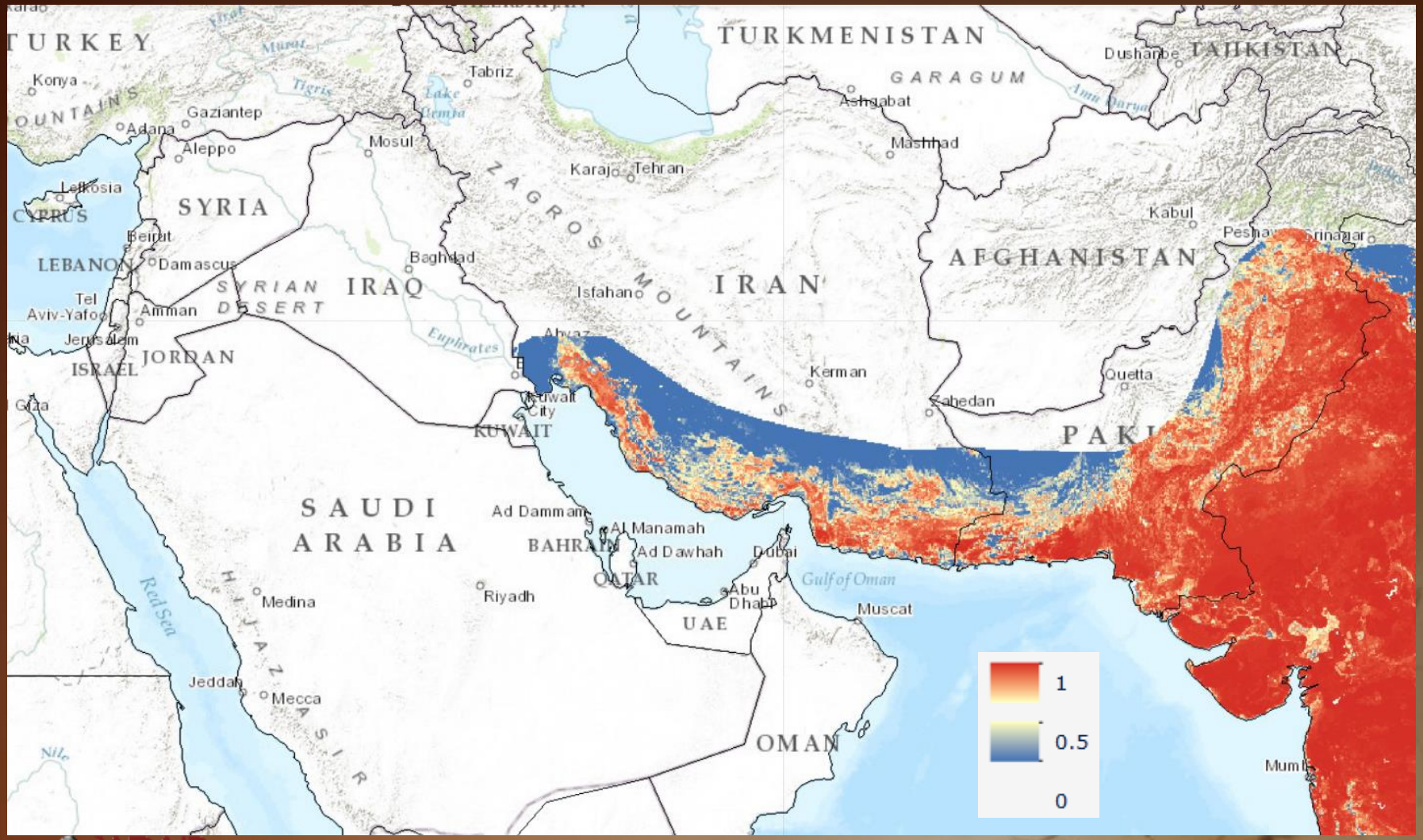
Back to Table of Contents

Habitat Suitability Models:
Anopheles (Cel.) culicifacies s.l.



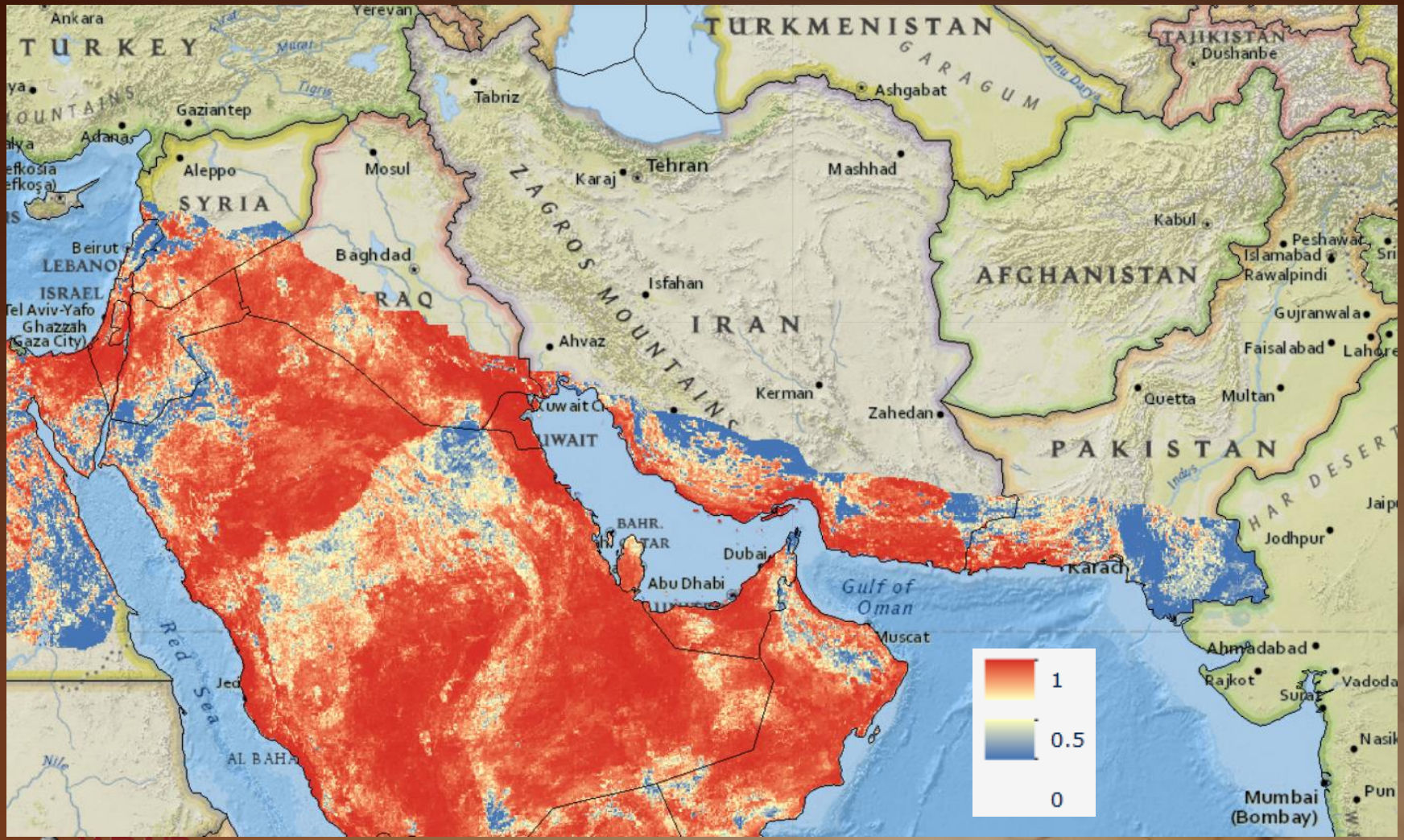
Back to Table of Contents

Habitat Suitability Model:
An. (Cel.) fluviatilis



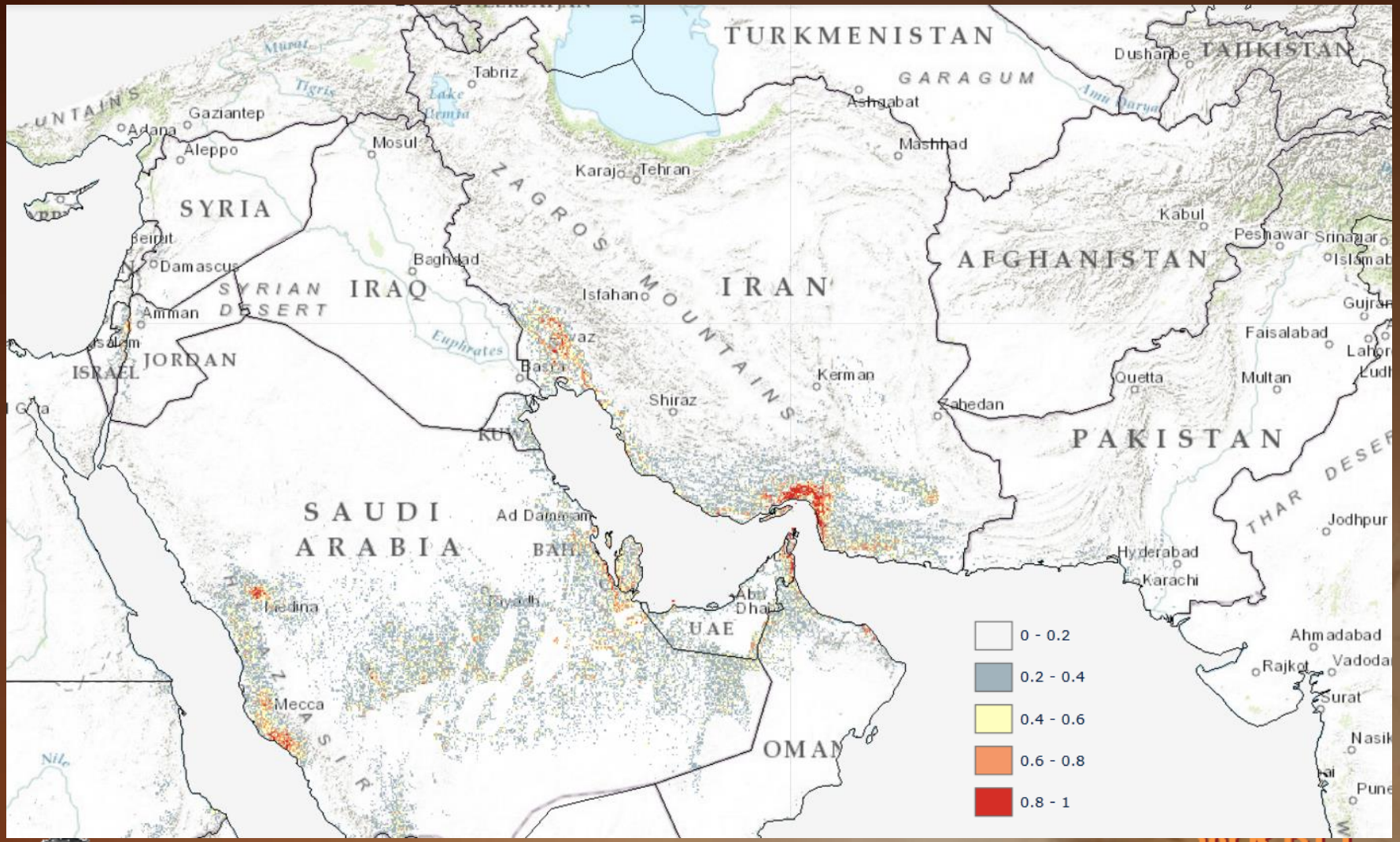
Back to Table of Contents

Habitat Suitability Model:
Anopheles (Ano.) sacharovi



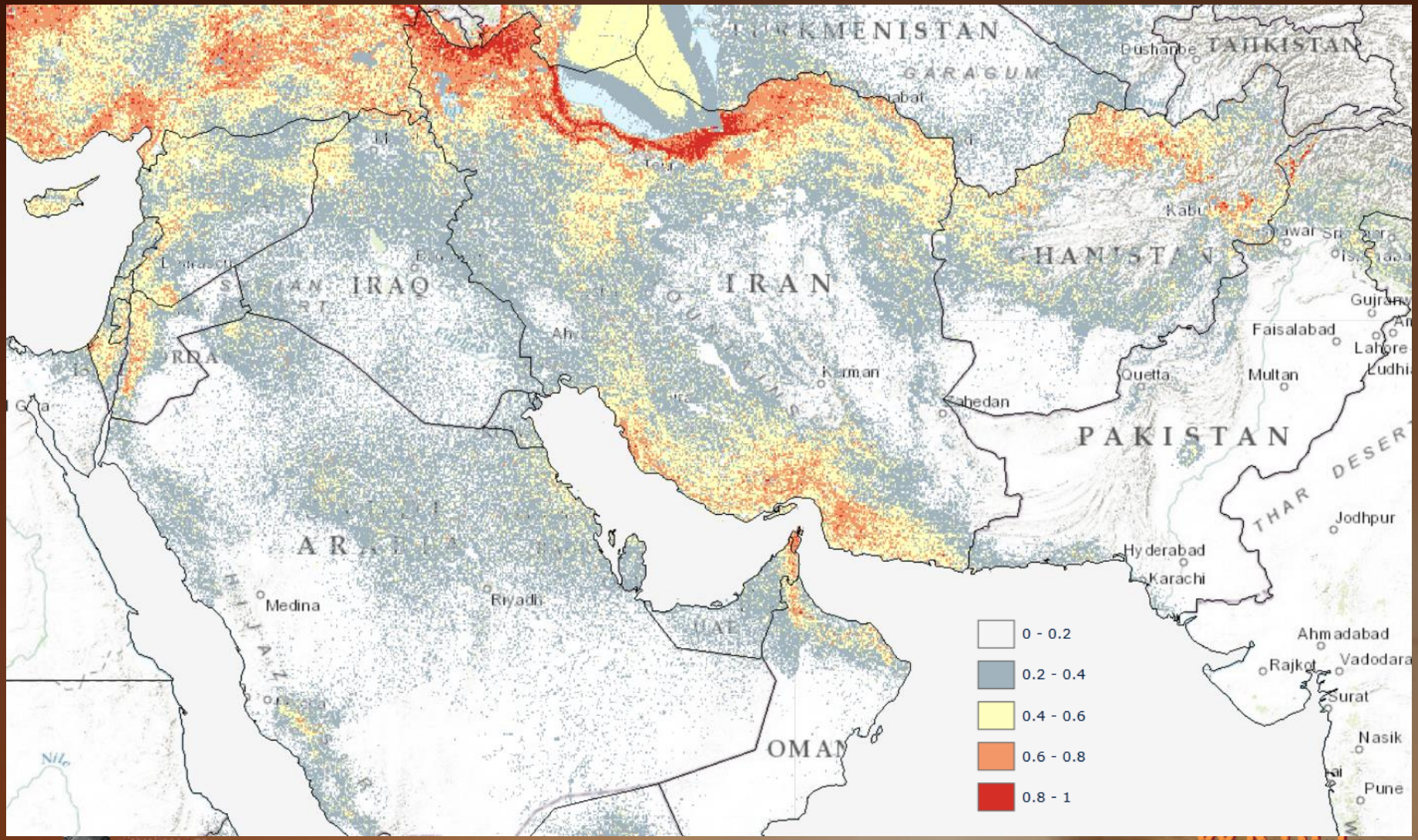
Back to Table of Contents

Habitat Suitability Model:
Anopheles (Cel.) stephensi



Back to Table of Contents

Habitat Suitability Model: *Anopheles (Cel.) superpictus*



Back to Table of Contents

Anopheles (Cel.) culicifacies Giles, 1901

Bionomics:
Larvae are found in fresh water irrigation ditches, rain pools, pools in riverbeds, freshly dug pits or holes and wells. Females avoid oviposition site with emergent vegetation. Larvae found between 35 and 960m. in Thailand; in Vietnam only over 914 and in Pakistan usually between 1524 - 1829 but also up to 2286m (Harrison 1980).

Medical Importance:
Primary malaria vector (Harrison 1980).

WRBU Catalog Species Page

Back to Table of Contents

Anopheles (Ano.) claviger Meigan 1804

Bionomics

In higher latitudes the larvae are found in permanent pond and lake margins especially where shade is present. In southern parts of its range the species is restricted to cool spring-fed pools and similar habitats (Bates in Boyd 1949).

Medical Importance

Malaria vector in Middle East but not considered a vector in Europe (Bates in Boyd 1949).

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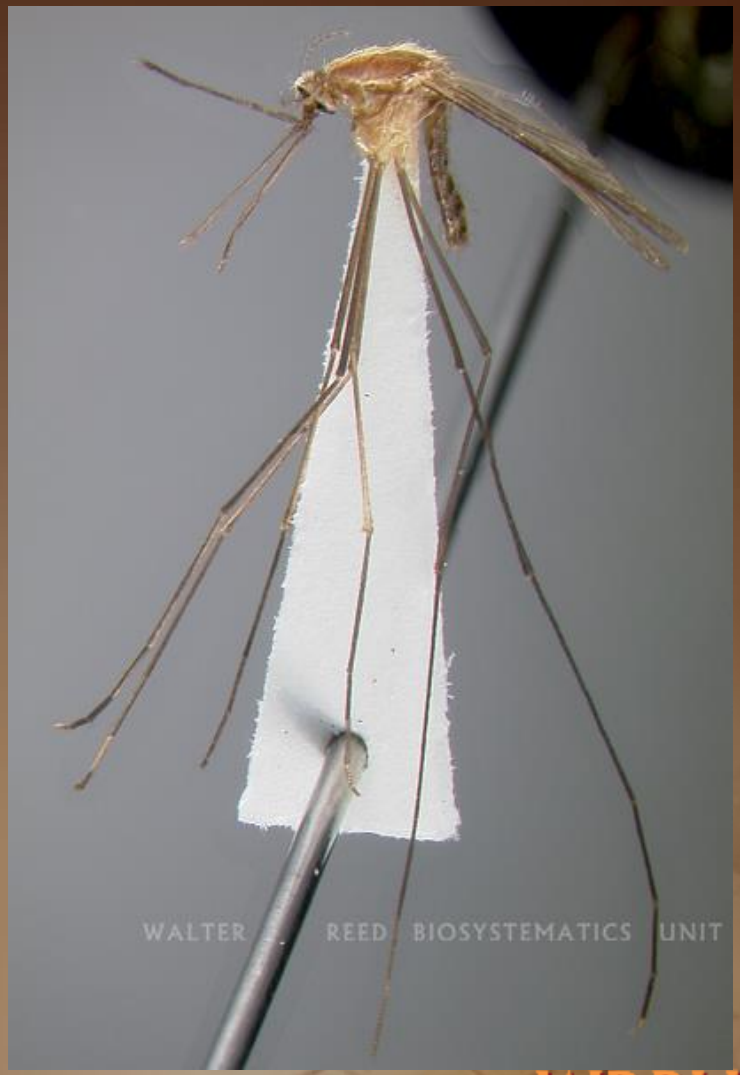


Back to Table of Contents

Anopheles (Ano.) fluviatilis James 1902

Bionomics:

Not usually found below 1000 ft. Larvae are found in the grassy edges of slow moving streams, springs, irrigation channels, sometimes in the edges of swamps and lakes. Females readily bite man, feeding generally before midnight
(Christophers 1933)

Medical Importance:

Primary malaria vector (Christophers 1933)

WRBU Catalog Species Page

Back to Table of Contents

Anopheles (Ano.) messeae Falleroni 1926

Bionomics

Larvae are characteristically found in great inland river valleys and large marshes. This species rarely bites man and is associated with malaria only in a few places where a rather dense human population lives in close association with large marshy areas (Bates in Boyd 1949)

Medical Importance

The species rarely bites man and is associated with malaria only in a few places where a rather dense human population lives in close association with large marshy areas (parts of Hungary, and Lake Malik in Albania) (Bates in Boyd 1949).

WRBU Catalog Species Page

Back to Table of Contents

Anopheles (Cel.) multicolor Cambouliu 1902

Bionomics

An inland and coastal breeder of semi-arid regions in pans, oases and collections of brackish water. Breeds in fresh water, cesspools and highly saline pools. Females readily enter houses and bite man (Gillies and deMeillon 1968).

Medical Importance

Secondary malaria vector (Gillies and deMeillon 1968).

WRBU Catalog Species Page

Back to Table of Contents

Anopheles (Cel.) pulcherrimus Theobald 1902

Bionomics

Larvae are found in warm, sunny, stagnant habitats with abundant submerged vegetation. Where sufficiently warm, rice fields are used. Females readily bite man and animals (Beklemischev in Boyd 1949).

Medical Importance

Secondary malaria vector (Beklemischev and Boyd 1949).

WRBU Catalog Species Page

Back to Table of Contents

Anopheles (Ano.) sacharovi Favre 1903

Bionomics

In the Mediterranean area it breeds typically in large brackish marshes though larvae may at times be found in a wide variety of habitats. Adults are anthropophagous (Bates in Boyd 1949).

Medical Importance

Primary malaria vector (Bates in Boyd 1949).

WRBU Catalog Species Page

Back to Table of Contents

Anopheles (Cel.) sergentii Theobald 1907

Bionomics

Larvae occur in oases and irrigated areas in many types of water, shaded and unshaded, with and without vegetation. Females enter houses and readily bite man, (Gillies and deMeillon 1968).

Medical Importance

Primary malaria vector,
(Gillies and deMeillon 1968).

WRBU Catalog Species Page

Back to Table of Contents

Anopheles (Cel.) stephensi Liston 1901

Bionomics

In urban areas the larvae are found in a wide variety of artifical containers, cisterns, wells, tubs and fountains. In the wild they are found in stream pools, stream margins, seepages, irrigation channels and springs. Females avidly bite man,
(Puri in Boyd 1949).

Medical Importance

Primary malaria vector,
(Christophers 1933)

WRBU Catalog Species Page

Back to Table of Contents

Anopheles (Cel.) superpictus Grassi 1899

Bionomics

Larvae are found in flowing water, including streams, rivers and irrigation channels in hilly and mountainous areas. Adults readily enter houses to bite man (Barraud 1933)

Medical Importance

Primary malaria vector,
(Beklemischev in Boyd 1949)

WRBU Catalog Species Page

Back to Table of Contents

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 one of a group of four viruses. Symptoms of Dengue include high fever, severe headache and joint pain (CDC, 2014).

The World Health Organization estimates that approximately 2.5 billion people are at risk from dengue with as many as 50 to 100 million annual infections. Currently it is now endemic in over 100 countries in Africa, the Americas, the Eastern Mediterranean, South-east Asia and the Western Pacific (WHO, 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).

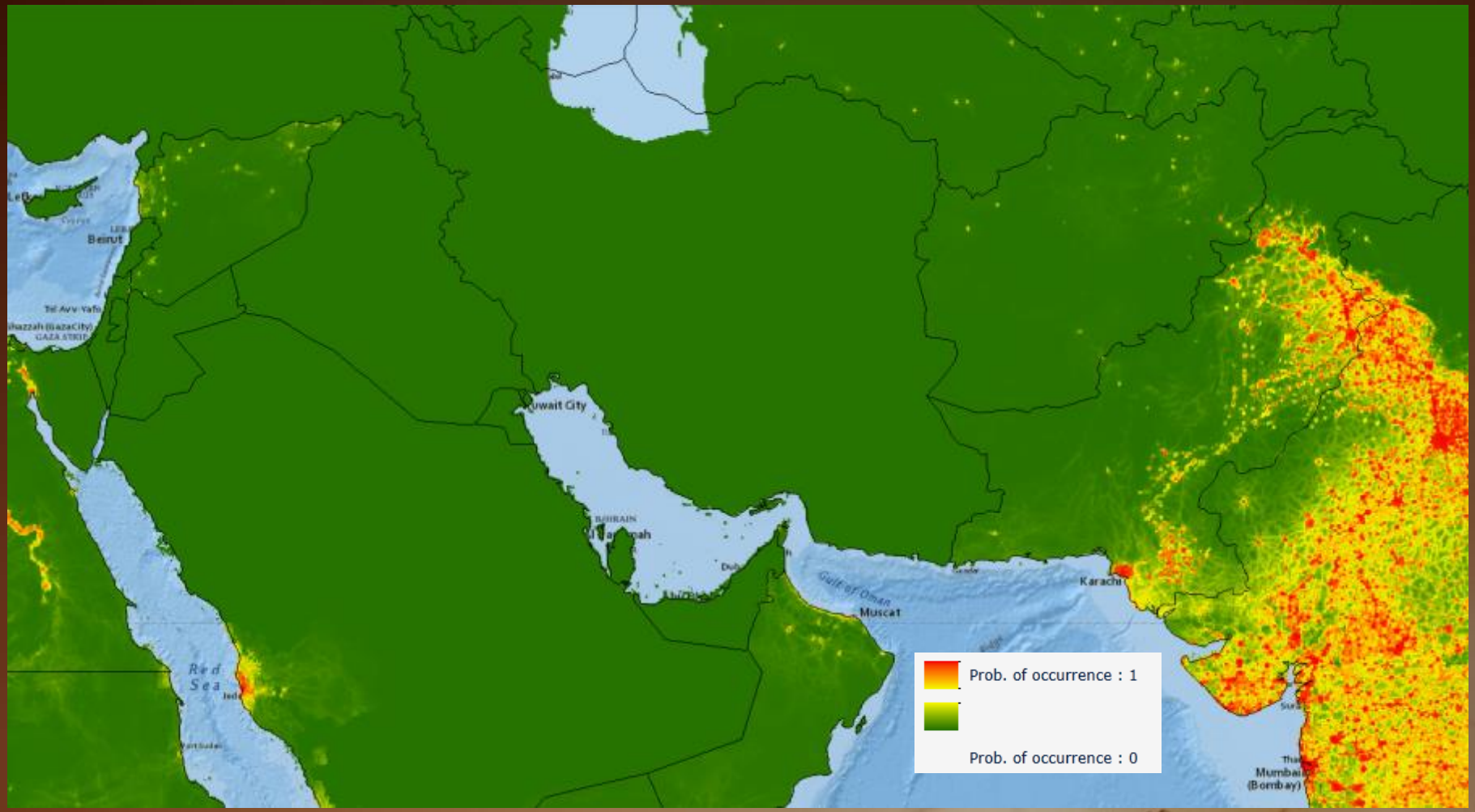
According to the World Health Organization (WHO), CHIKV has been reported in over 40 countries in Asia, Africa, Europe and also in the Americas (WHO, 2014).

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

Back to Table of Contents

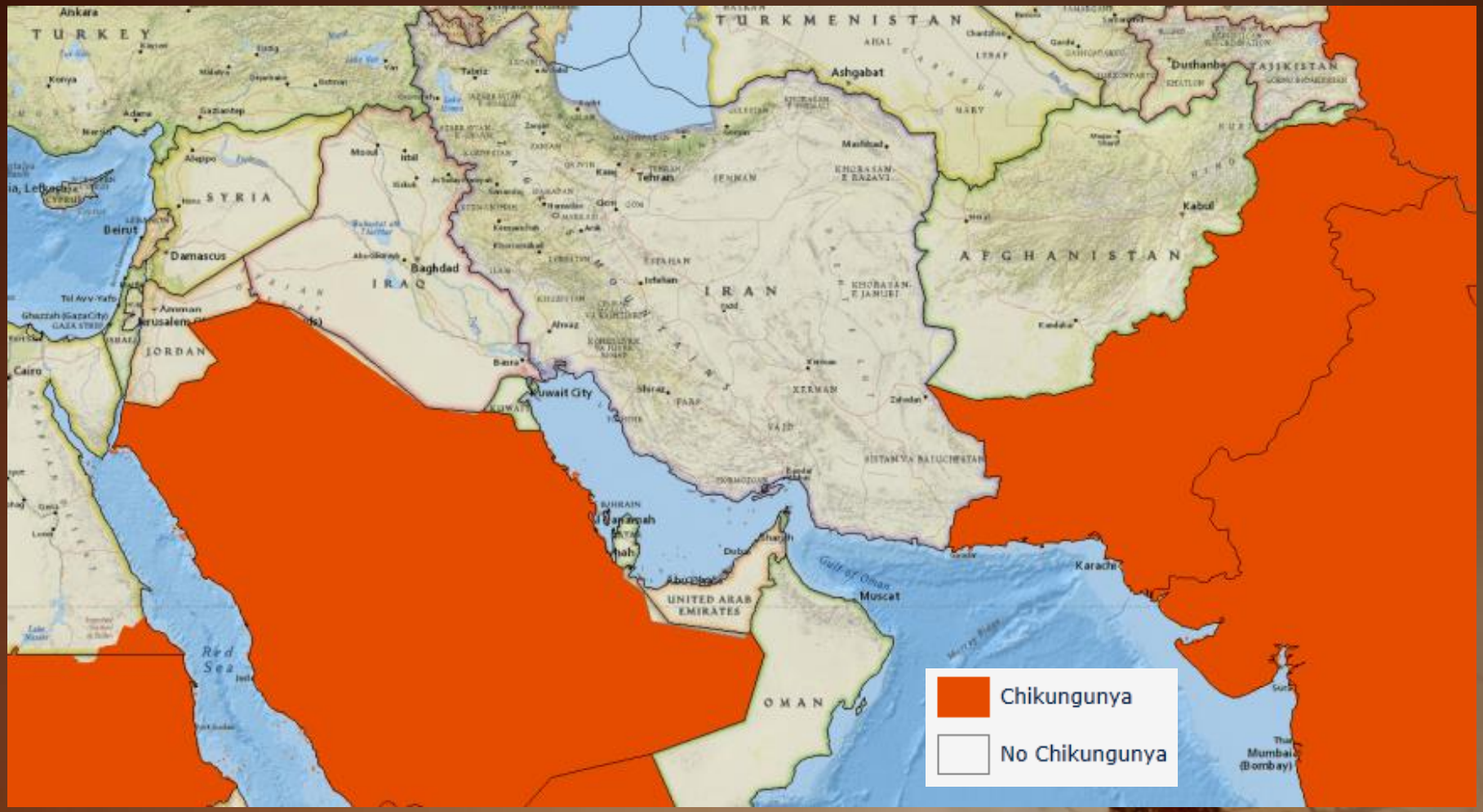
Dengue Virus Prediction Model

-Bhatt, S. et al. 2013



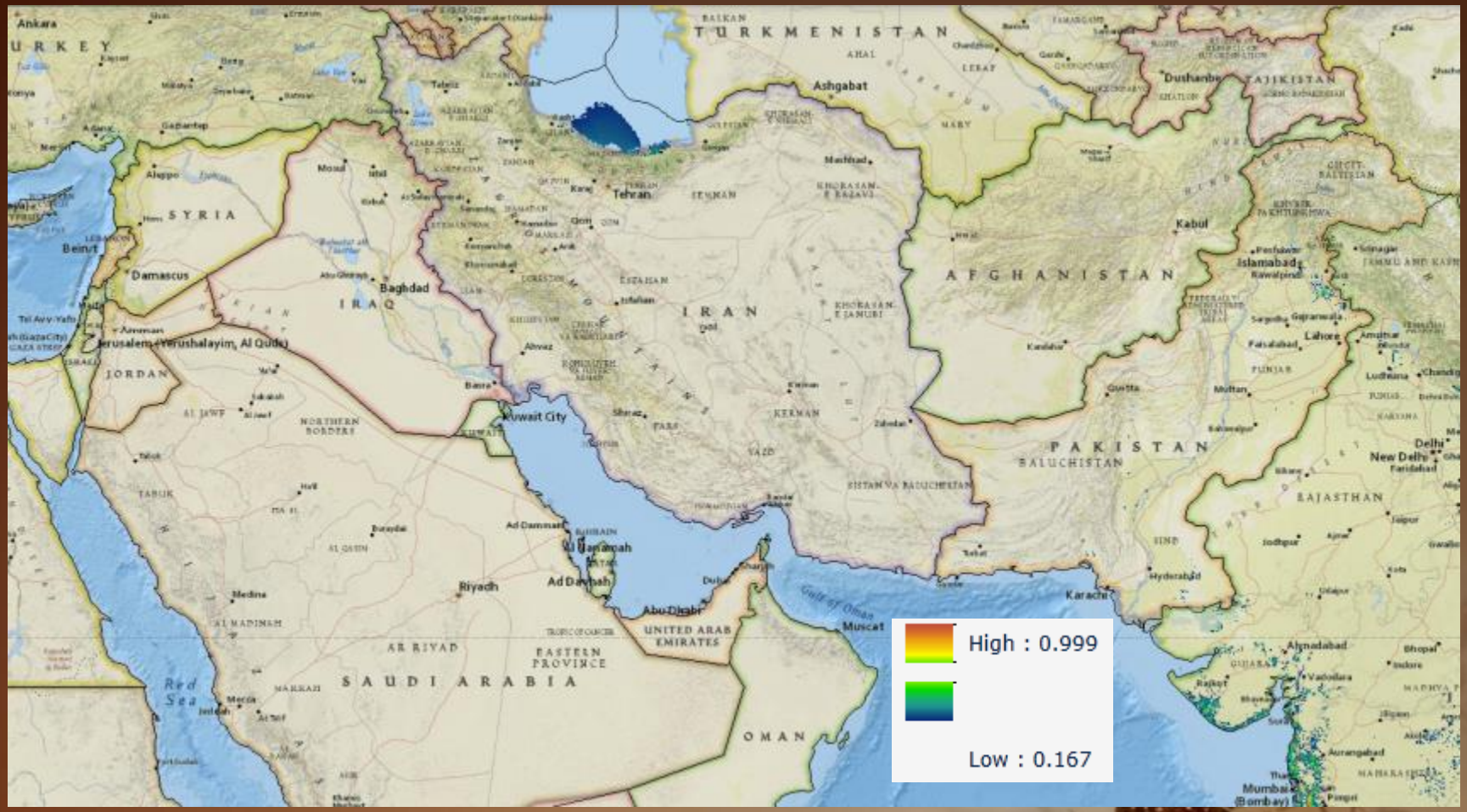
Back to Table of Contents

Countries reporting CHIKV cases to CDC as of March 2015



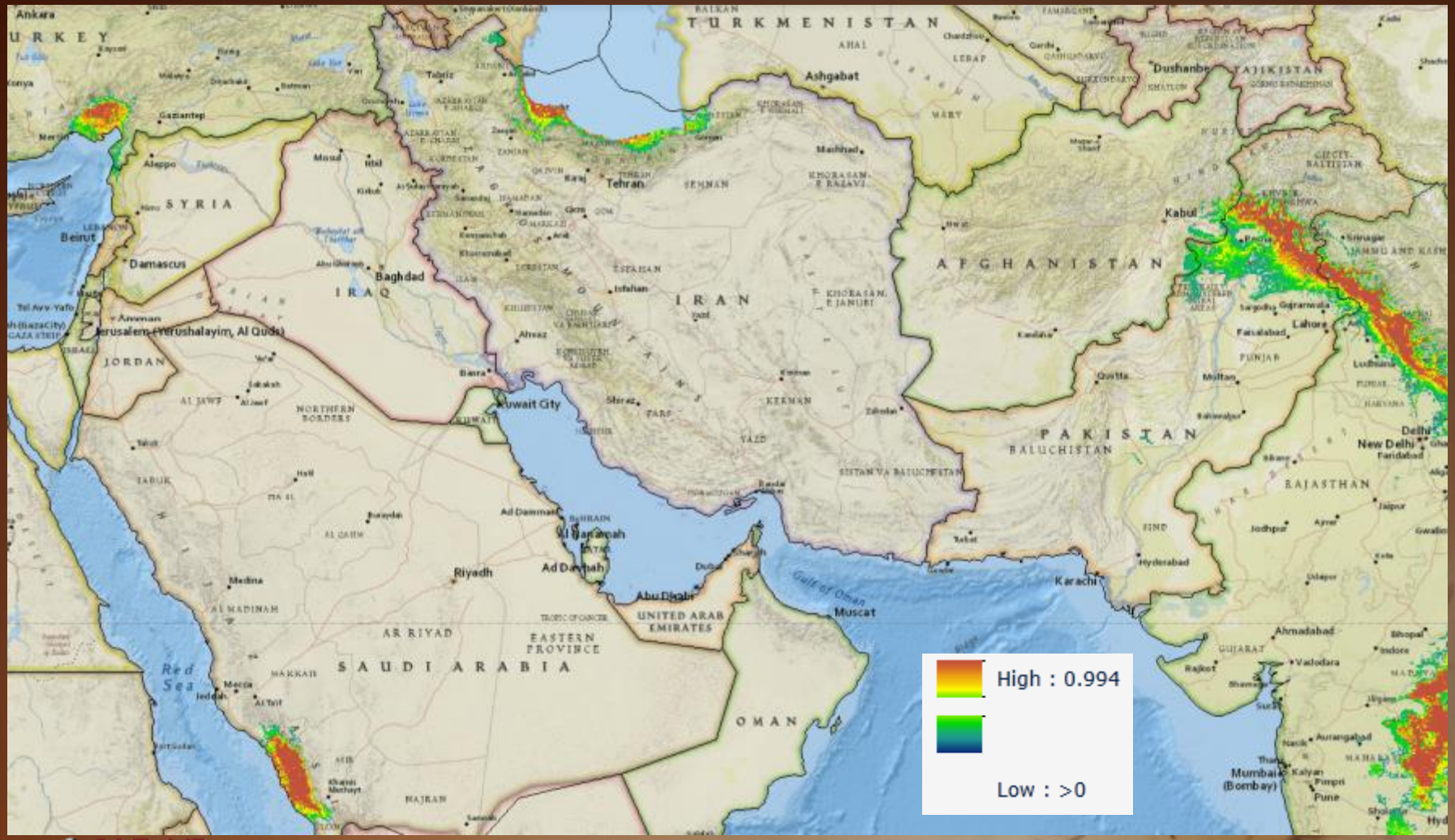
Back to Table of Contents

Habitat Suitability Model:
Aedes aegypti



Back to Table of Contents

Habitat Suitability Model:
Aedes albopictus



Back to Table of Contents

Aedes (Stg.) aegypti (Linnaeus, 1762) "Yellow Fever Mosquito"

Bionomics:

In association with man, 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).

WRBU Catalog species page

Back to Table of Contents

Aedes (Stg.) albopictus (Skuse, 1894)
"Asian Tiger Mosquito"

Bionomics:
Also known as the "Asian Tiger Mosquito", the immatures are found in natural containers, including treeholes, bamboo stumps, coconut shells, rockholes, palm fronds, and leaf axils. They are also found in all varieties of artificial containers and will breed indoors. The females readily bite man (Huang 1972).

Medical Importance:
This species is a known vector of dengue and yellow fever in the wild. Under laboratory conditions it has also been shown to vector bird malarias, Eastern and Western equine encephalitis, West Nile, chikungunya and Japanese encephalitis viruses (Huang,1972).

WRBU Catalog species page

Back to Table of Contents

West Nile Virus

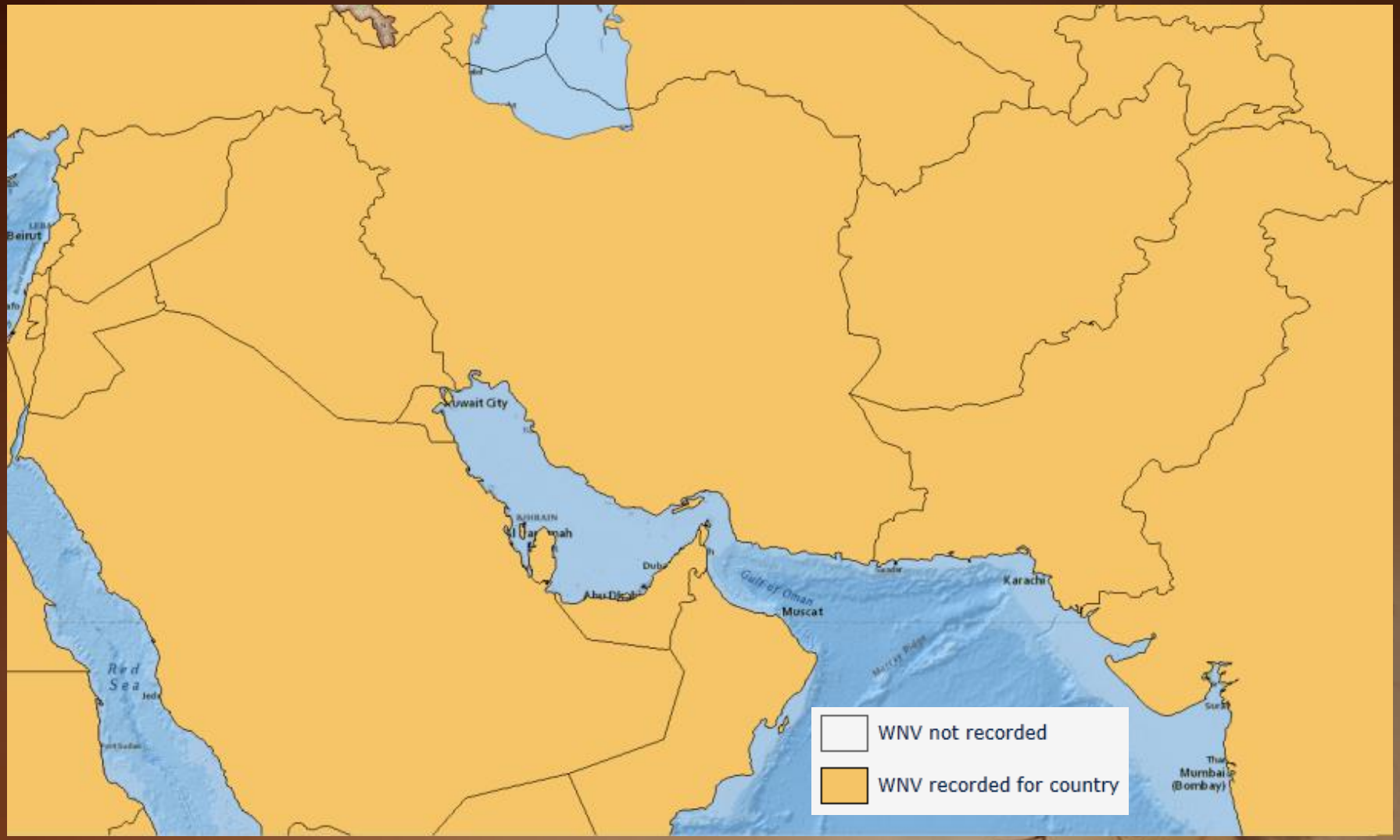
West Nile Virus is a mosquito-borne illness that primarily cycles between mosquitoes and birds. If enough of the virus is present in an infected bird and a mosquito takes a blood meal, that mosquito can then transmit the virus to a humans and other mammals. Mammals are a ‘dead-end’ host to WNV as there is typically not enough virus within a mammal to infect mosquitoes. (CDC, 2014)

According to the CDC, most people infected with WNV do not show symptoms. Approximately 1 in 5 infected people will show symptoms of fever and other flu-like symptoms. Fewer than 1% of humans infected with WNV will develop a serious, sometimes fatal, neurologic illness. (CDC, 2014)

Back to Table of Contents

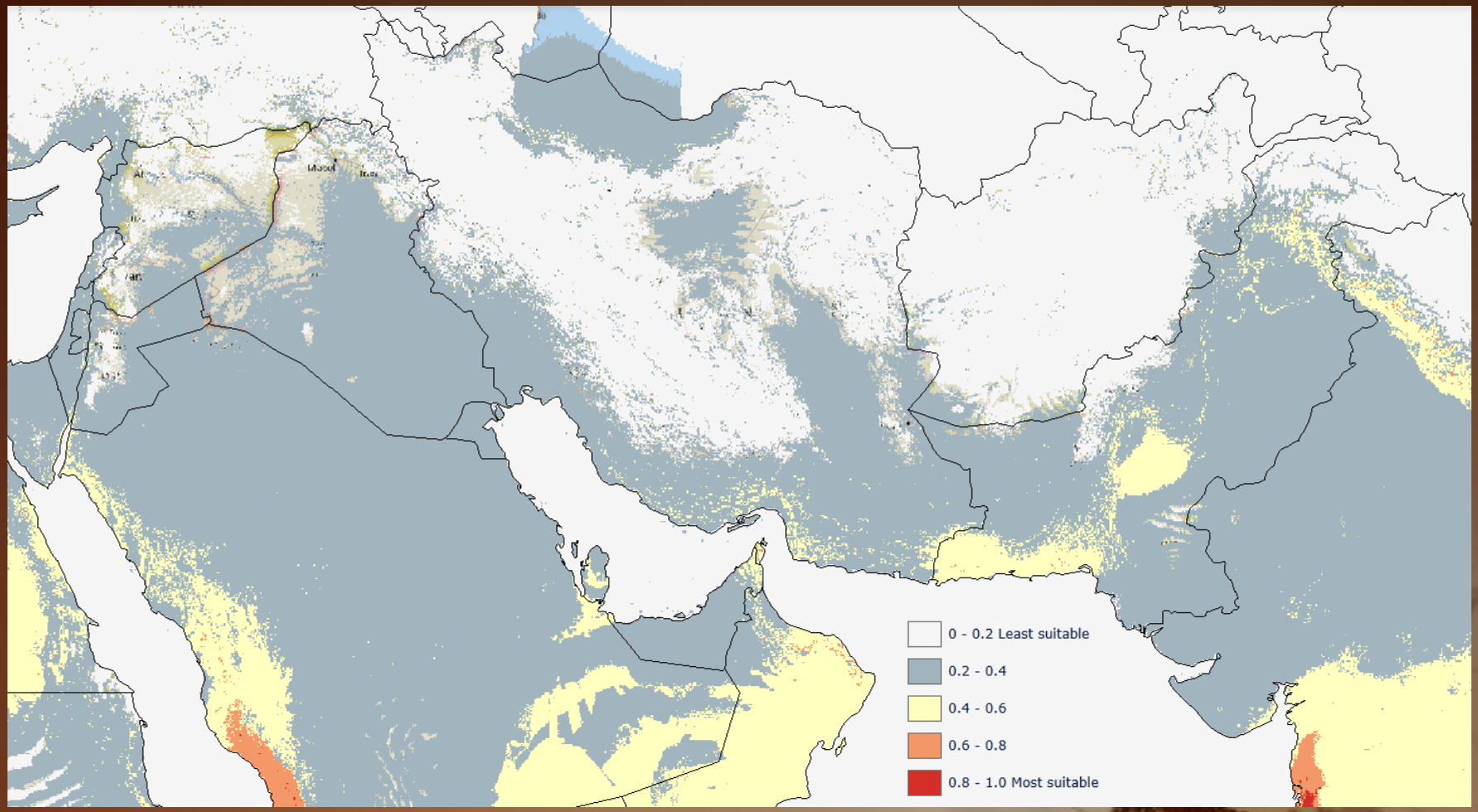
Countries Reporting West Nile Virus

CDC, 2000



Back to Table of Contents

Habitat Suitability Model:
Aedes vexans



Back to Table of Contents

Habitat Suitability Model:
Culex (Cux.) pipiens

Back to Table of Contents

Aedes (Adm.) vexans (Meigan, 1830)

Bionomics

Immatures are found in unshaded fresh water flood pools in secondary scrub, but have also been collected in ditches, swamps, rice fields, and elephant foot prints. Habitats usually have little aquatic vegetation or algae. Females are night biters and readily feed on man and cattle (Reinert 1973).

Medical Importance

Capable of transmitting Eastern equine encephalitis virus (EEE), Western equine encephalitis virus (WEE), SLE, West Nile Virus (WNV) (Turell et al. 2005:60). It is also a vector of dog heartworm (Reinert 1973).

WRBU Catalog Species Page

Back to Table of Contents

Aedes (Och.) dorsalis (Meigan, 1830)

Bionomics

The larvae of *Ae. dorsalis* occur in a variety of habitats including both brackish and fresh water. They are often found in large numbers in tidal marshes but also occurs in fresh-water marshes and in overflow from artesian wells and irrigation ditches. (Carpenter and LaCasse 1955:176)

Medical Importance

Ae. dorsalis is considered a vector of Western Equine Encephalitis (WEE) and West Nile Virus (WNV) (Turell et al. 2005:60).

WRBU Catalog Species Page

Back to Table of Contents

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)

WRBU Catalog Species Page

Back to Table of Contents

References

Maxent model of *Ae. aegypti* habitat suitability. A. Nyari. GlobalUniqueIdentifier: USNM:MosquitoModel:Ae_aegypti_Nyari_1
Maxent model of *Ae. vexans* habitat suitability. A. Nyari. GlobalUniqueIdentifier: USNM:MosquitoModel:Ae_vexans_Nyari_1
Maxent model of *Ae. albopictus* habitat suitability. GlobalUniqueIdentifier: USNM:MosquitoModel:Ae_albopictus_Dornak_1
Maxent model of *Ae. aegypti* habitat suitability
Maxent model of *Cx. pipiens* habitat suitability, Dornak, L.
Maxent model of *An. superpictus* habitat suitability, Dornak, L.
Maxent model of *An. stephensi* habitat suitability, Dornak, L.
An. culicifacies species complex. Sinka et al. 2011. Malaria Atlas Project.
An. fluviatilis species complex. Sinka et al. 2011. Malaria Atlas Project.
An. sacharovi species complex. Sinka et al. 2011. Malaria Atlas Project.

- CDC. Countries where West Nile Virus is present in year 2000. http://www.cdc.gov/ncidod/dvbid/westnile/map.htm
- CDC. Countries with reported current or previous local transmission of chikungunya virus (as of Oct 21, 2014). http://www.cdc.gov/chikungunya/map/index.html
- Plasmodium falciparum, Temp suitability index. The normalized Z(T) index of temperature suitability that incorporates not just the duration but also the degree of suitability across an average year. Source: Gething et al. Parasites & Vectors 2011, 4:92.
- Plasmodium vivax, Temp suitability index. The normalized Z(T) index of temperature suitability that incorporates not just the duration but also the degree of suitability across an average year. Source: Gething et al. Parasites & Vectors 2011, 4:92.
- Plasmodium falciparum, Infectious Days. The number of days in an average year in which the annual temperature regime could support potentially infectious vectors. Source: Gething et al. Parasites & Vectors 2011, 4:92.
- Plasmodium vivax, Infectious Days. The number of days in an average year in which the annual temperature regime could support potentially infectious vectors. Source: Gething et al. Parasites & Vectors 2011, 4:92
- Estimated proportion of the general population that are infected with P. vivax at any one time, averaged over the 12 months of 2010. Malaria Atlas Project http://www.map.ox.ac.uk/browse-resources/endemicity/Pv_mean/world/
- Bhatt, S. et al. 2013. The Global Distribution and Burden of Dengue. Natrure, 496: 504-507.

Mosquito images courtesy of J. Stoffer, Walter Reed Biosystematics Unit

Back to Table of Contents

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Know the vector, know the threat

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.

The published material reflects the views of the authors and should not be construed to represent those of the Department of the Army or the Department of Defense.

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Back to Table of Contents

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