Predicted global distribution of *Burkholderia pseudomallei* and burden of melioidosis

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Wellcome-Trust Intermediate Fellowship

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For Annual Scientific Meeting of Indonesian Society for Clinical Microbiology (PIT PAMKI) 2017

IS IT AN IMPORTANT DISEASE ?

In a single 1,000 bed-side hospital in northeast Thailand

Am. J. Trop. Med. Hyg., 82(6), 2010, pp. 1113–1117
doi:10.4269/ajtmh.2010.10-0038

Increasing Incidence of Human Melioidosis in Northeast Thailand

Picture is for a general idea, and does not represent the resources available currently

In a single 1,000 bed-side hospital in northeast Thailand

Am. J. Trop. Med. Hyg., 82(6), 2010, pp. 1113–1117
doi:10.4269/ajtmh.2010.10-0038

Increasing Incidence of Human Melioidosis in Northeast Thailand

~300 culture-confirmed cases per year

Year	Average annual rainfall (mm) in Ubon Ratchathani province	Melioidosis patients (*N*)	Deaths
1997	1,555.1	198	97
1998	1,318.3	257	124
1999	1,582.5	173	71
2000	1,844.6	141	67
2001	1,709.4	152	61
2002	1,677.3	184	83
2003	1,560.4	235	90
2004	1,471.1	250	99
2005	1,323.0	273	110
2006	1,526.7	380	154

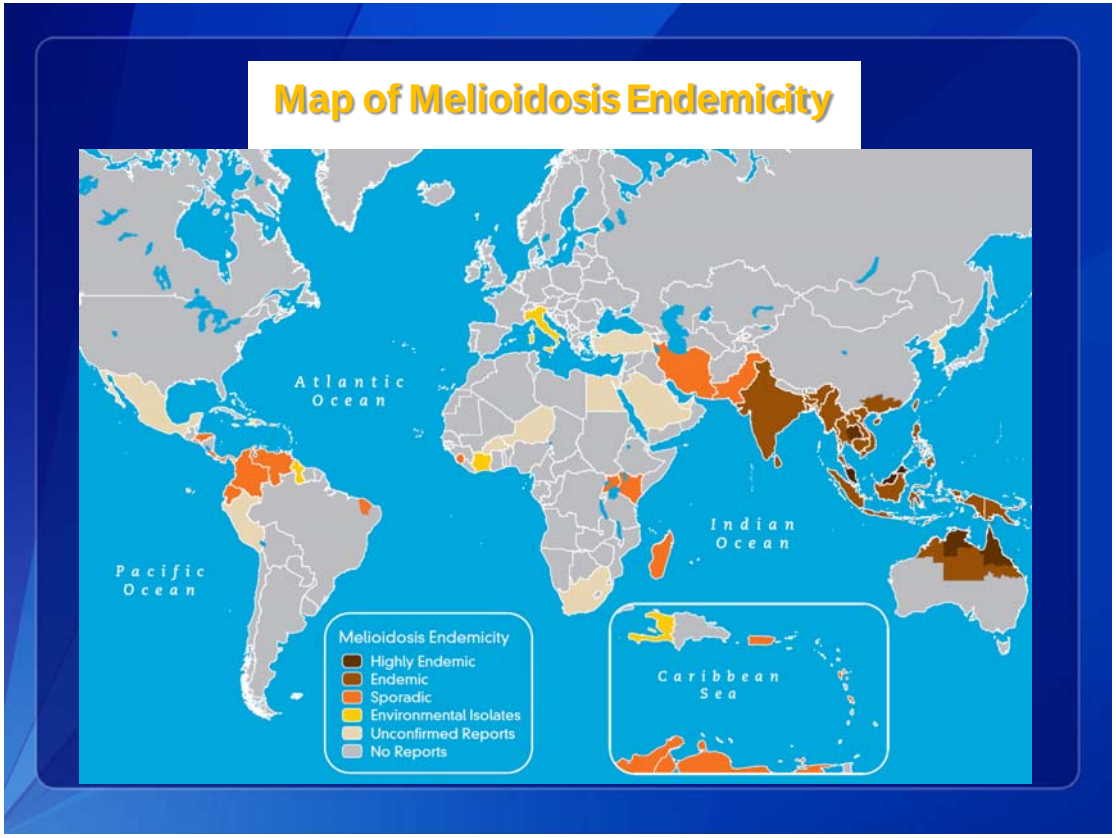
Spearman correlation coefficient between the number of patients and the level of annual rainfall = [illegible]89; $P < 0.001$.

~100 died each year

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2877420/

Problems

1.) Complete global distribution of *B. pseudomallei* is still unknown



- Current map is incomplete because it is based on locations of [1] good microbiological research facilities and [2] those who are aware of the disease

Problems

2.) The total number of people die of melioidosis each year is unknown

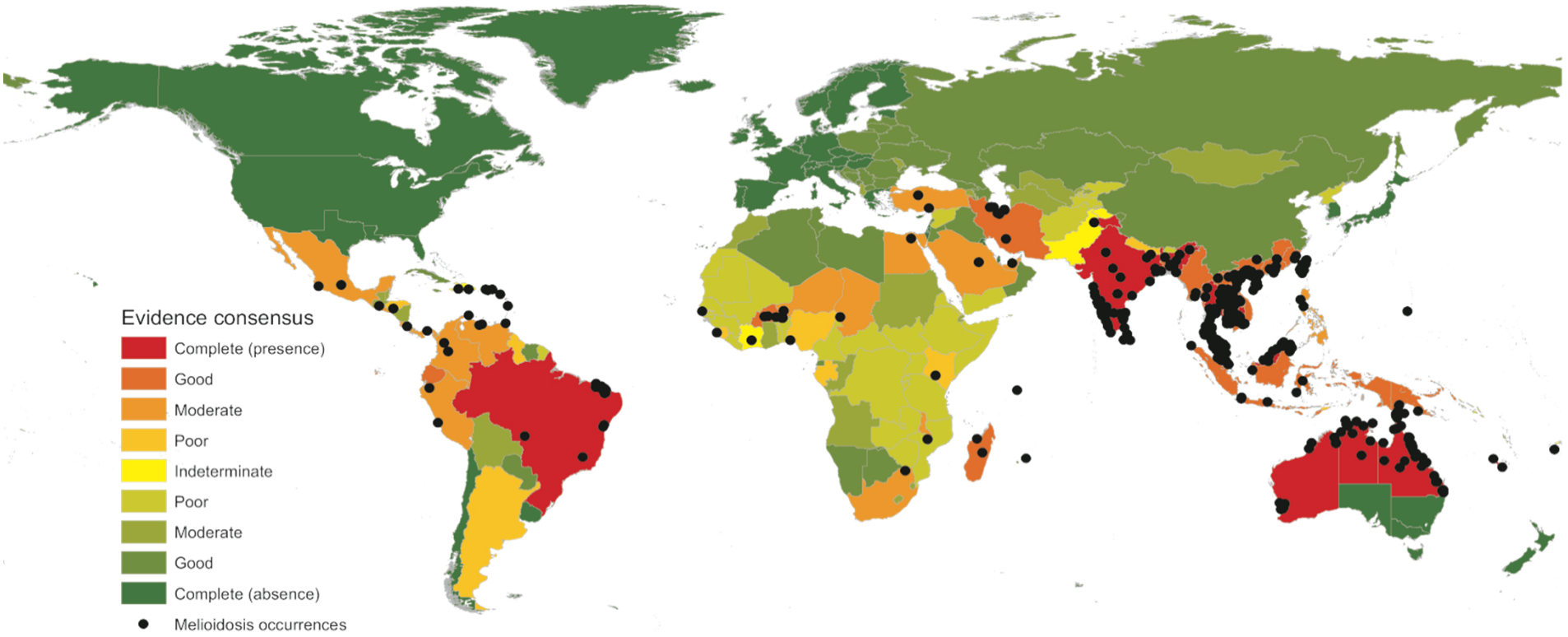
World Health Organization

- It is the main question that policy makers such as “World Health Organization (WHO)” and “Ministry of Health” in each country want to know the answer

HOW MANY DIE OF MELIOIDOSIS PER YEAR WORLDWIDE ?

Predicted global distribution of *B. pseudomallei* and burden of melioidosis (Nature Microbiology, 2016)

Methods and Results [1]: Assembled 22,338 geo-located records of human and animal melioidosis and presence of environmental *B. ps* from reports from 1910 to 2014



Evidence consensus was developed as published previously [Brady et al, PLoS NTD,2012;6(8):e1760]

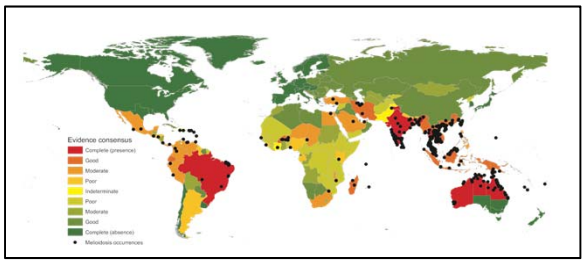
Predicted global distribution of *B. pseudomallei* and burden of melioidosis (Nature Microbiology, 2016)

Methods and Results [2]: Used boosted regression tree models to estimate environmental suitability for *B. pseudomallei* at a resolution of 5km x 5km

Harmonized world soil database and others

Database (spatial at 5km x 5 km) of soil type, soil pH, soil salinity, %sand, %clay, %silt, %gravel, %organic carbon, %gypsum, etc; and land surface temperature, precipitation and vegetation index

Occurrence records



BRT models

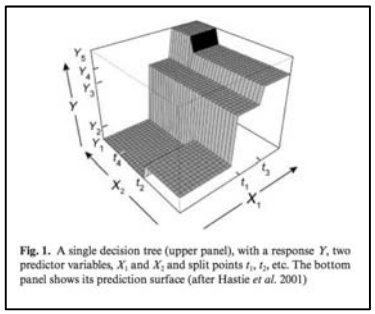


Fig. 1. A single decision tree (upper panel), with a response Y, two predictor variables, X_1 and X_2 and split points t_1, t_2, etc. The bottom panel shows its prediction surface (after Hastie *et al.* 2001)

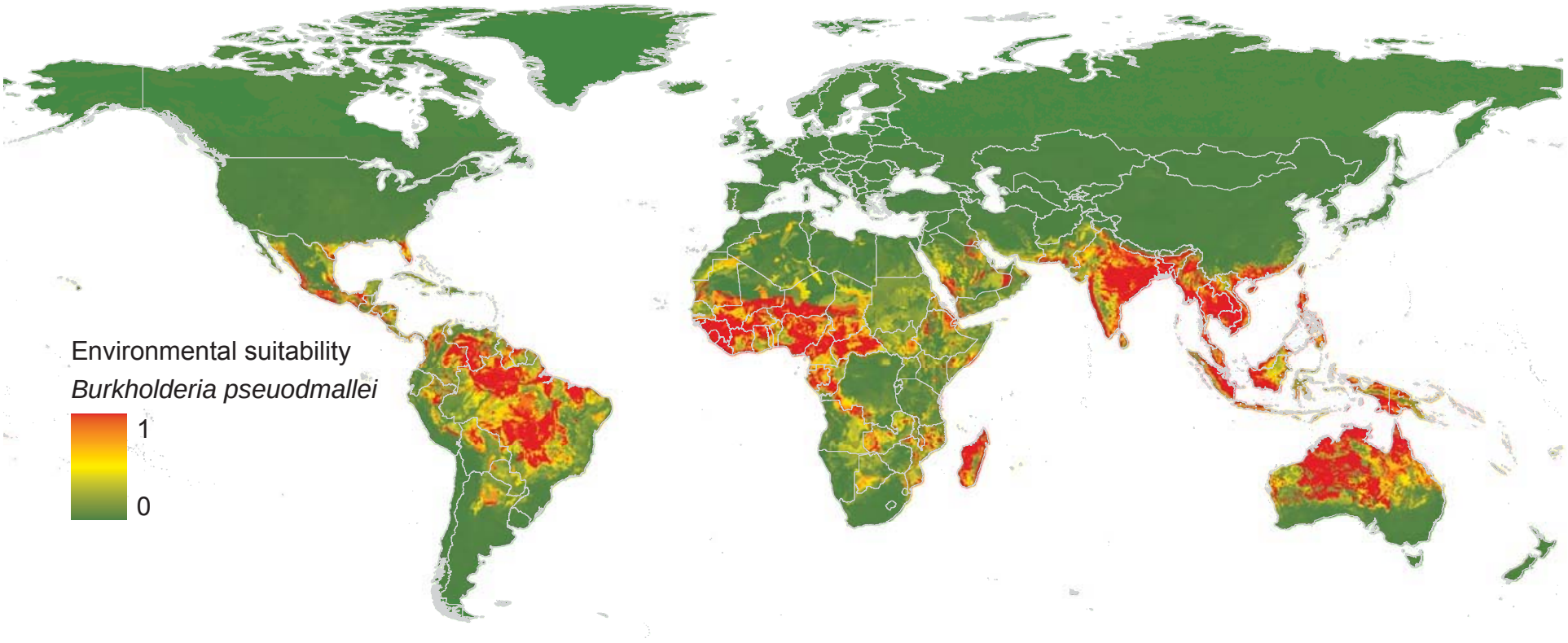
Predicted environmental suitability

Next slide

[Reference for BRT model: Elith et al. J Ani Ecol, 2008;77,802-813]

Predicted global distribution of *B. pseudomallei* and burden of melioidosis (Nature Microbiology, 2016)

Methods and Results [3]: Used boosted regression tree models to estimate environmental suitability for *B. pseudomallei* at a resolution of 5km x 5km



BRT model was developed as published previously [Bhatt et al, Nature,2013;496:504-507]

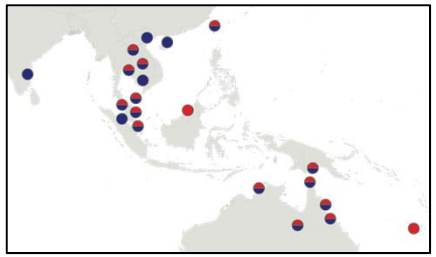
Predicted global distribution of *B. pseudomallei* and burden of melioidosis (Nature Microbiology, 2016)

Methods and Results [4]: Used negative binomial models and logistic regression models to predicted incidences and mortalities caused by melioidosis globally in 2015

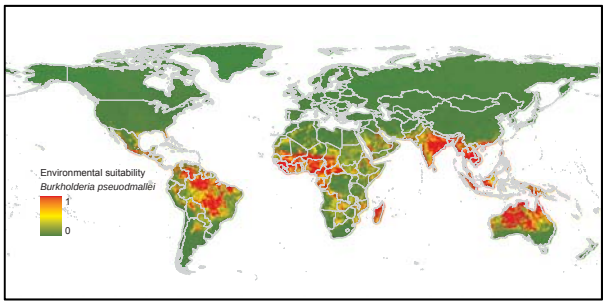
Spatial population data

GRUMP data (population), High-income country, Prevalence of diabetes, and Prevalence of indigenous Australians

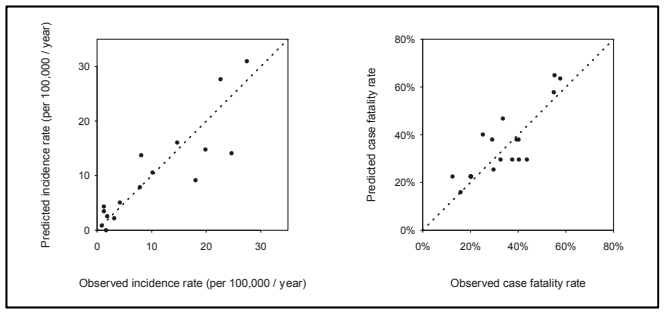
Study reported incidence and mortality rates



Predicted Env. suitability



Negative binomial and logistic models



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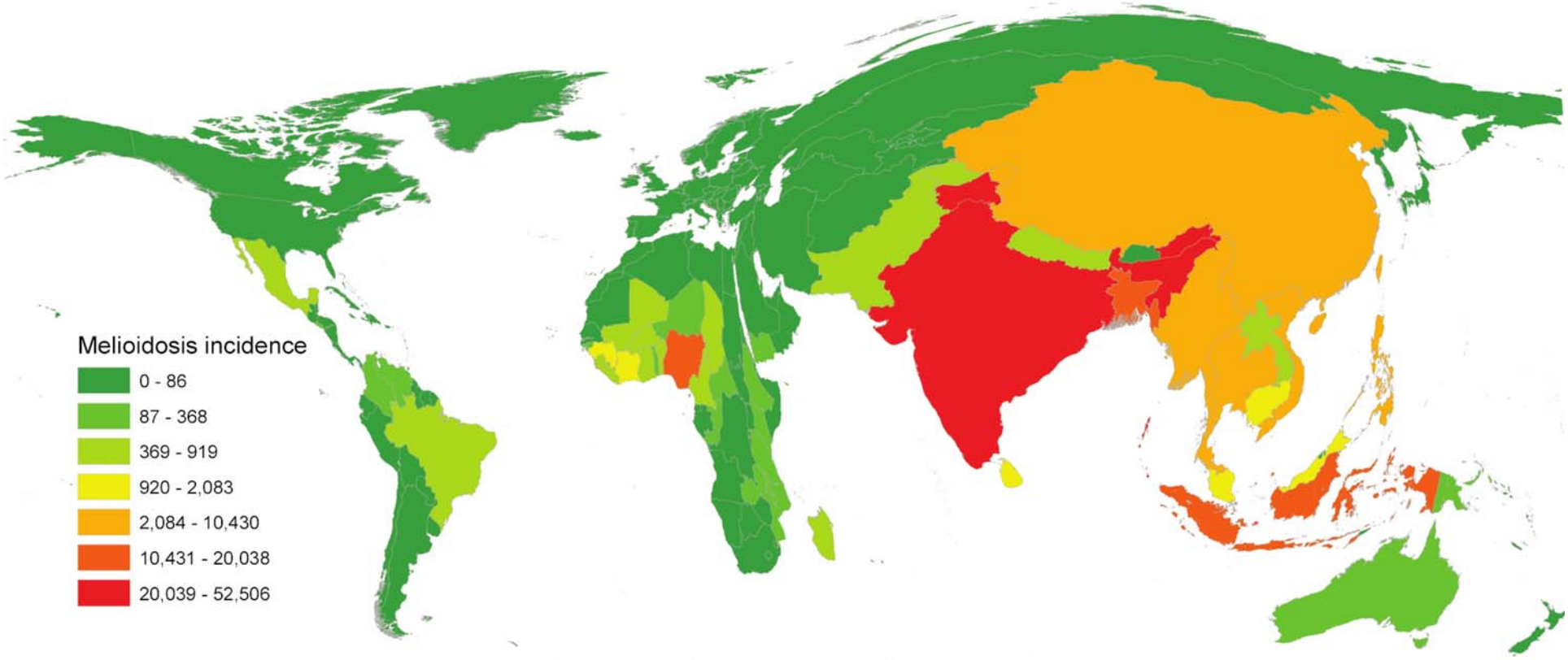
[GRUMP: http://sedac.ciesin.org/data/collection/grump-v1; IDF website; World bank website]

Predicted global distribution of *B. pseudomallei* and burden of melioidosis (Nature Microbiology, 2016)

Methods and Results [5]: We estimate there to be 165,000 (95%CI 68,000-412,000) human melioidosis cases per year worldwide, of which 89,000 (95%CI 36,000-227,000) die.



Cartogram of the incidence as a proportion of national geographical area in 2015; **44% is in South Asia**

Predicted global distribution of *B. pseudomallei* and burden of melioidosis (Nature Microbiology, 2016)

Methods and Results [6]: Our estimates suggest that mortality due to melioidosis is **substantial**, highlighting the need for public health officials and policymakers in 79 countries to raise the priority of this disease.

Country name	Predicted incidence	Predicted mortality
India *	52506 (22335 - 124652)	31425 (13404 - 75601)
Indonesia *	**20038 (7859 - 52812)**	**10224 (3944 - 27524)**
Bangladesh *	16931 (7814 - 37794)	9454 (4325 - 21621)
Nigeria *	13481 (4839 - 38348)	8324 (2959 - 23933)
Vietnam *	10430 (4097 - 27480)	4703 (1827 - 12631)
Philippines *	9116 (4819 - 18999)	4510 (2369 - 9739)
Thailand *	**7572** (3396 - 17685)	**2838** (1259 - 6678)
China *	7174 (3099 - 15752)	2614 (1148 - 5828)
Myanmar *	6247 (2513 - 15400)	3687 (1449 - 9299)

* Endemic but under reported

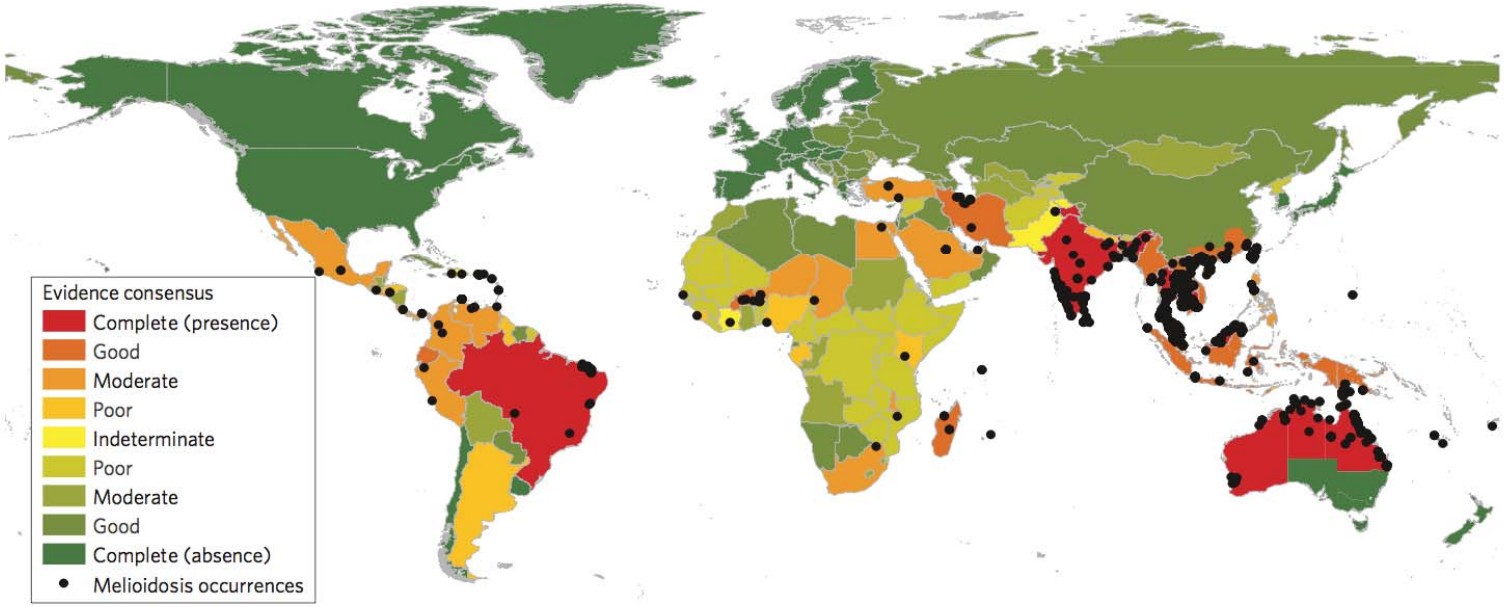
nature microbiology

LETTERS

PUBLISHED: 11 JANUARY 2016 | ARTICLE NUMBER: 15008 | DOI: 10.1038/NMICROBIOL.2015.8

Predicted global distribution of *Burkholderia pseudomallei* and burden of melioidosis

Direk Limmathurotsakul[1,2,3]*, Nick Golding[1], David A. B. Dance[4,5], Jane P. Messina[6], David M. Pigott[1], Catherine L. Moyes[1], Dionne B. Rolim[7], Eric Bertherat[8], Nicholas P. J. Day[2,5], Sharon J. Peacock[2,9,10] and Simon I. Hay[1,11,12]



WHY HAVE I NOT HEARD ABOUT THIS FROM MOPH ?

Notifiable Disease System in Thailand

In 2013, only 4 deaths of melioidosis was reported to the system

ปี พ.ศ. 2556 (ค.ศ. 2013) สำนักระบาดวิทยา ได้รับรายงานผู้ป่วยโรคเมลิออยโดสิส จาก 61 จังหวัดจำนวน 2,836 ราย อัตราป่วย 4.39 ต่อประชากรแสนคน เสียชีวิต 4 ราย อัตราตาย 0.0062 ต่อประชากรแสนคน

http://www.boe.moph.go.th/Annual/AESR2013/

THE NATION
IN SIGHTFUL TREND DEPENDENT

NATIONAL »

Farmers warned of disease outbreak in Northeast

By The Nation
Published on August 25, 2010

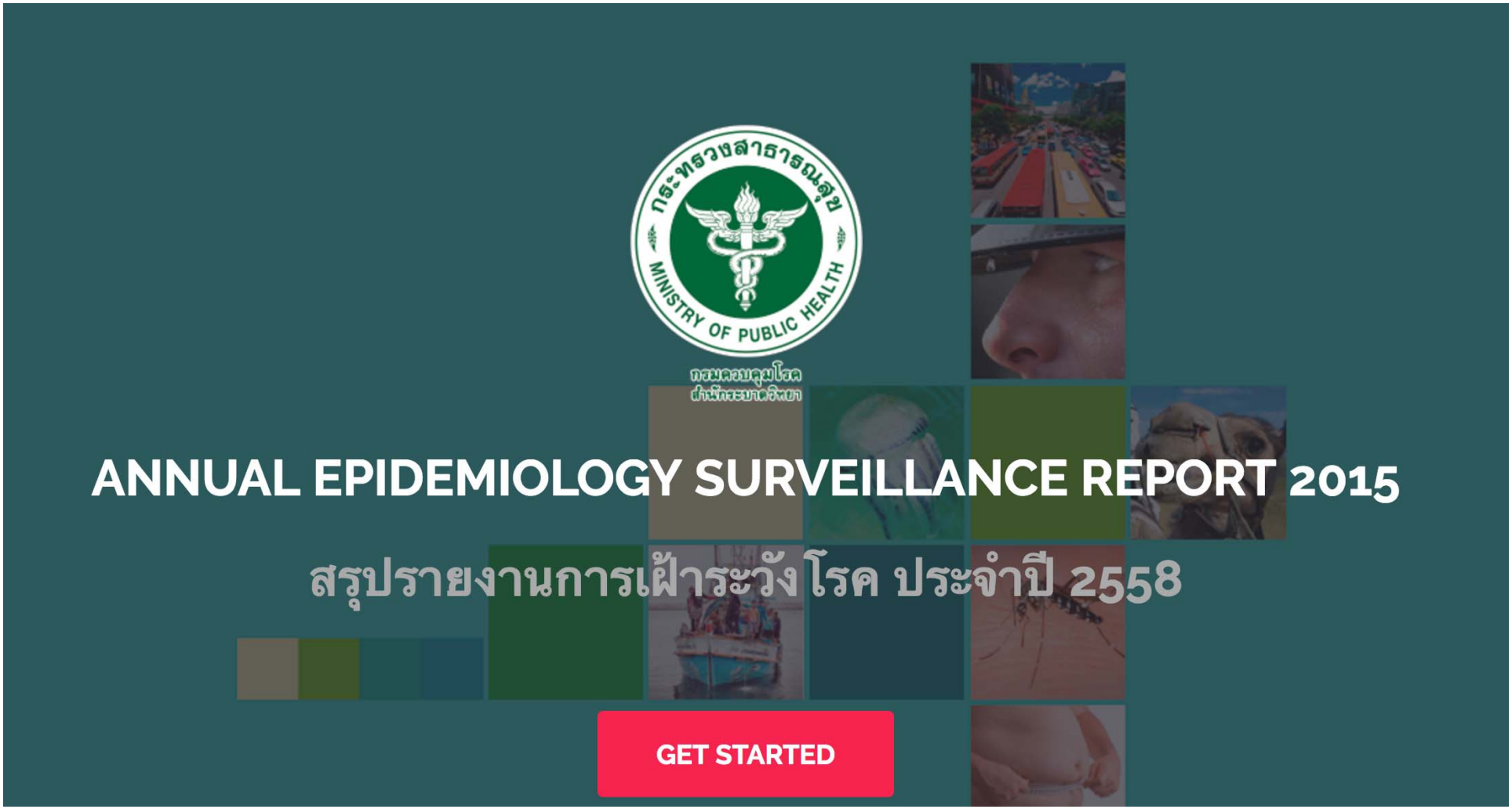
An outbreak of the water-borne disease melioidosis has infected 1,307 people and caused six deaths this year - mainly among farmers in the Northeast.

Public Health Minister Jurin Laksanawisit has warned farmers to avoid wading through water and walking over soil with bare feet because the bacteria burkholderia pseudomallei, which causes melioidosis, is common in soil and water.

"Melioidosis caused six deaths",
Ministry of Public Health Thailand

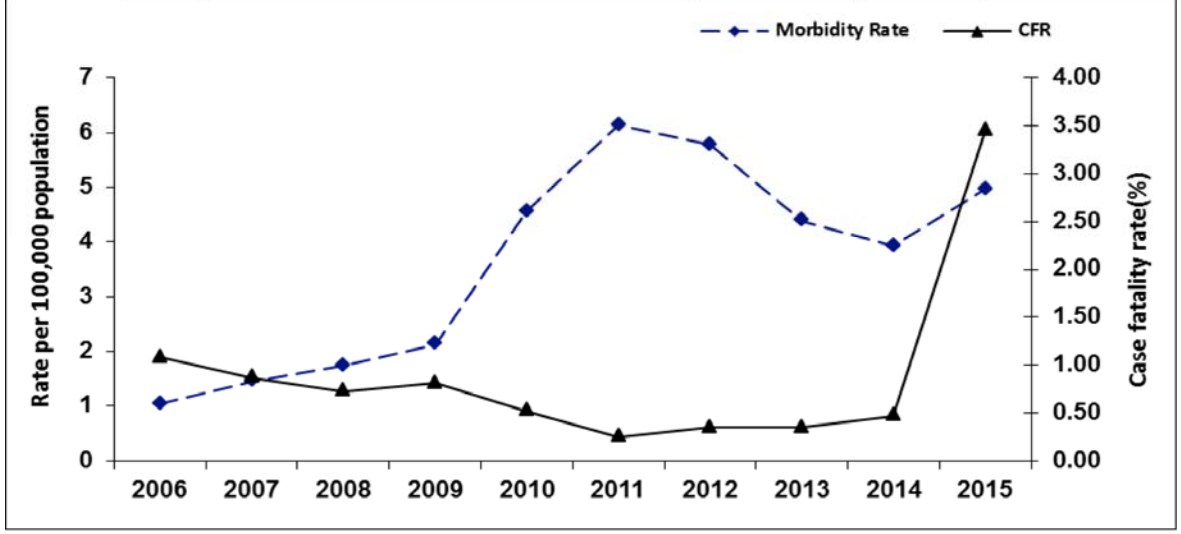
Thailand-Lao Melioidosis Network

- ***Initiated in 2012***
- ***Raised the problems why it has been badly neglected***
- ***How to solve it ?***


กระทรวงสาธารณสุข
MINISTRY OF PUBLIC HEALTH
กรมควบคุมโรค
สำนักระบาดวิทยา
ANNUAL EPIDEMIOLOGY SURVEILLANCE REPORT 2015
สรุปรายงานการเฝ้าระวังโรค ประจำปี 2558
GET STARTED

ในปี พ.ศ.2558 (ค.ศ.2015) สำนักระบาดวิทยา ได้รับรายงานโรคจากระบบเฝ้าระวัง (รายงาน 506) พบผู้ป่วยโรคเมลิออยโดสิส 3,242 ราย อัตราป่วย 4.96 ต่อประชากรแสนคน (5) ซึ่งพบว่าผู้ป่วยส่วนใหญ่อยู่ในภาคตะวันออกเฉียงเหนือ โดยเฉพาะจังหวัดมุกดาหาร อัตราป่วย 50.71 ต่อประชากรแสนคน รองลงมาคือ อำนาจเจริญ ศรีสะเกษ อุบลราชธานี และร้อยเอ็ด อัตราป่วย 32.19, 29.65, 25.93 และ 22.70 ต่อประชากรแสนคนตามลำดับ (รูปที่ 1) และพบผู้เสียชีวิต 112 ราย อัตราตาย 0.17 ต่อประชากรแสนคน อัตราป่วยตายร้อยละ 3.45 ซึ่งพบว่าอัตราป่วยตายพุ่งสูงขึ้นจากปีที่ผ่านมา (รูปที่ 2) โดยเฉพาะจังหวัดอุบลราชธานีที่พบผู้เสียชีวิตสูงถึง 107 ราย

Fig Reported Cases of Meliodosis per 100,000 Population and Case Fatality Rate by Year,



After 3 years of working together, death data of Ubon Ratchathani (107 deaths) was successfully in the system (in 2015)

Conclusion

- Burden of melioidosis is formidable.
- In regions where melioidosis is predicted to be endemic but under- or never-diagnosed,

[1] providing awareness to **clinicians**,

[2] improving **microbiological facilities**,

[3] implementing diagnostic **guideline** for proper bacterial culture

[4] training for the **bacterial identification**, and

[5] **reporting system** should be urgently strengthened

so that accurate diagnosis treatment and prevention are provided.

Acknowledgement: www.melioidosis.info

Nick Golding,
SEEG, Oxford

David Dance,
LOMWRU, Laos

Prof Sharon Peacock,
Cambridge

Prof Simon Hay
SEEG, Oxford

Eric Bertherat
WHO

Prof Nicholas Day
MORU, Thailand

Rungrueng Kitphati
Ministry of Public Health, Thailand

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Mahidol Oxford MORU
WELLCOME TRUST - MAHIDOL UNIVERSITY - OXFORD TROPICAL MEDICINE RESEARCH PROGRAMME
OXFORD
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spatial ecology and epidemiology group
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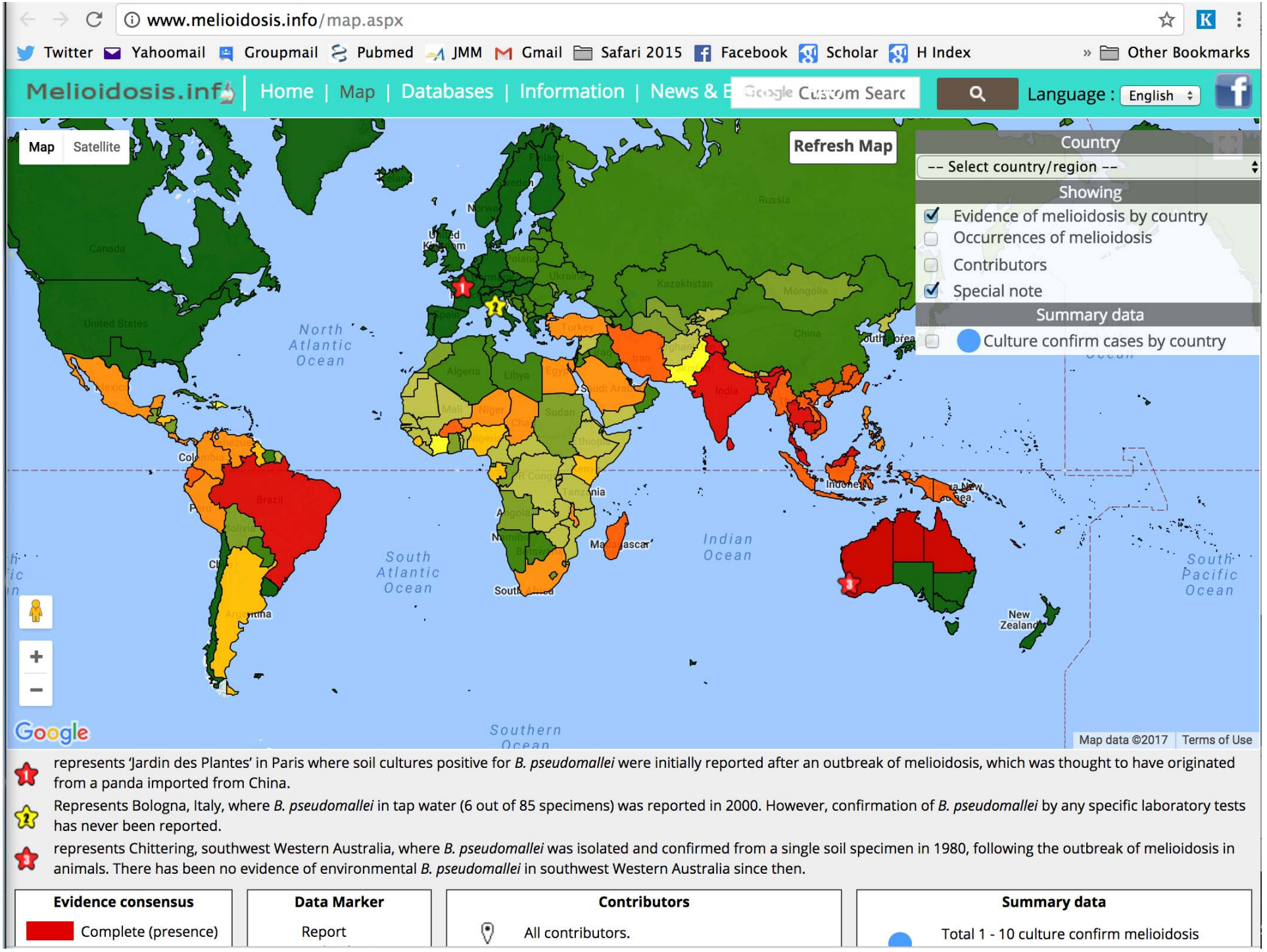
World Health Organization

www.melioidosis.info



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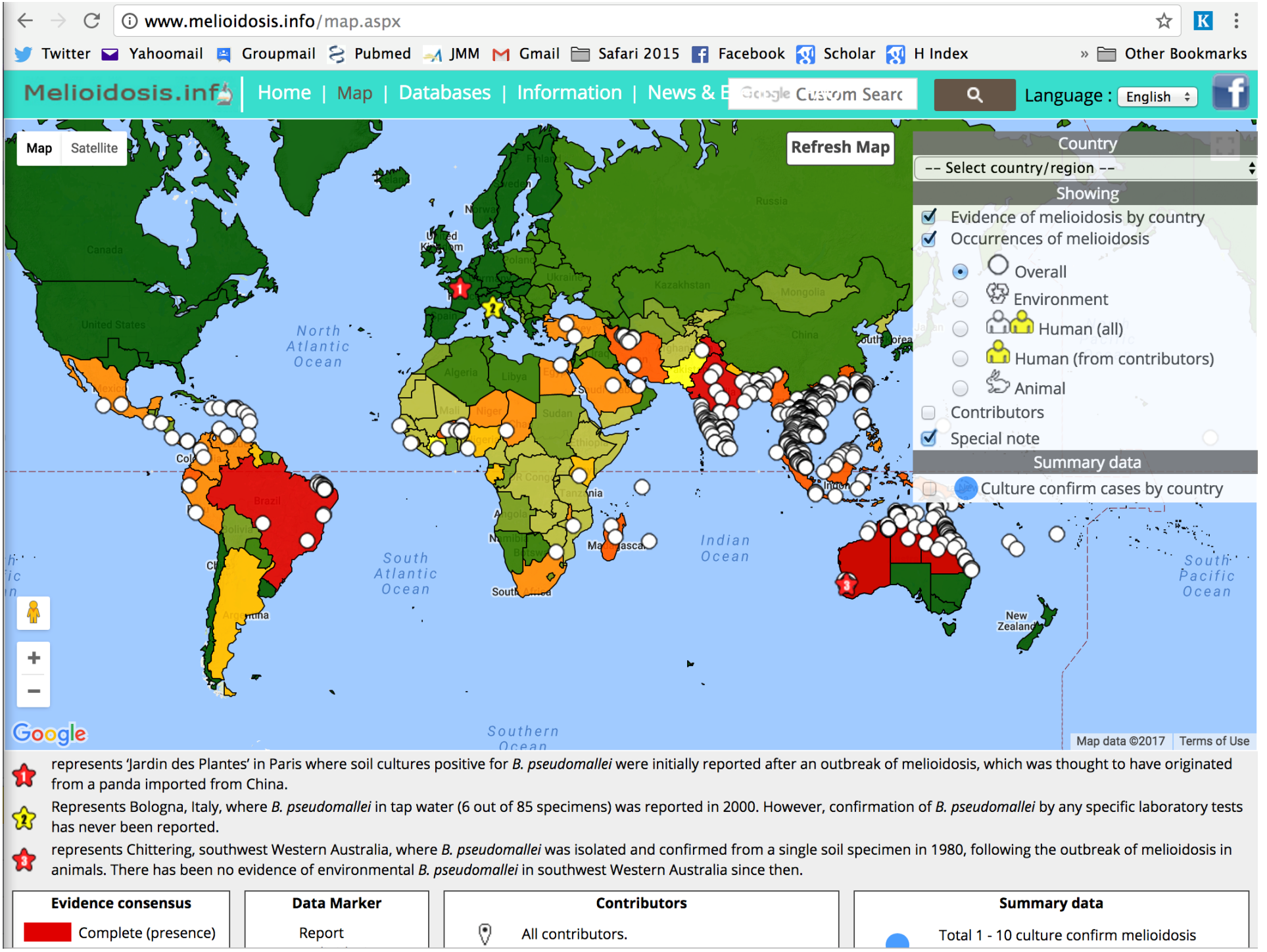
Represents Bologna, Italy, where *B. pseudomallei* in tap water (6 out of 85 specimens) was reported in 2000. However, confirmation of *B. pseudomallei* by any specific laboratory tests has never been reported.

represents Chittering, southwest Western Australia, where *B. pseudomallei* was isolated and confirmed from a single soil specimen in 1980, following the outbreak of melioidosis in animals. There has been no evidence of environmental *B. pseudomallei* in southwest Western Australia since then.

Evidence consensus	Data Marker	Contributors	Summary data
Complete (presence)	Report	All contributors.	Total 1 - 10 culture confirm melioidosis



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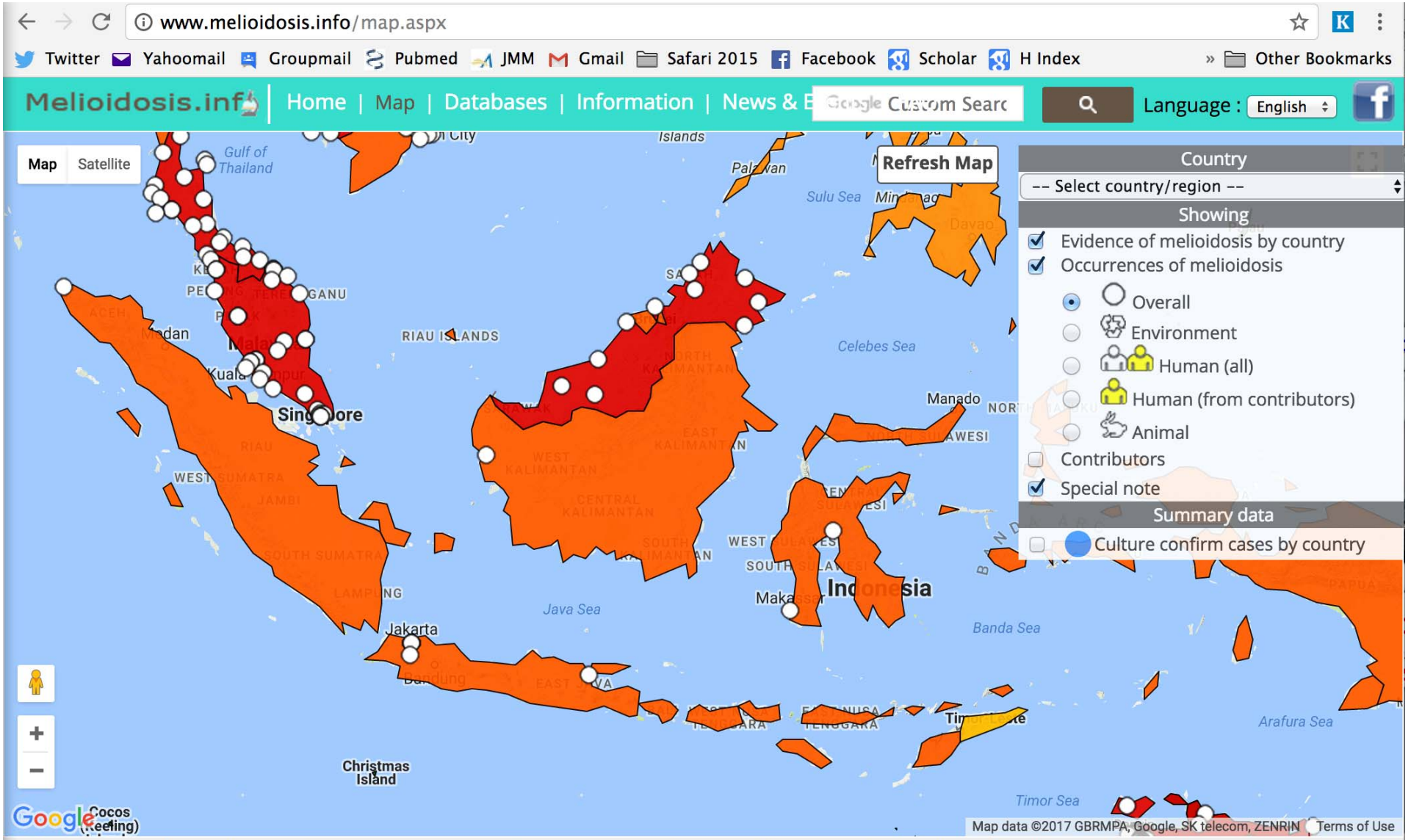

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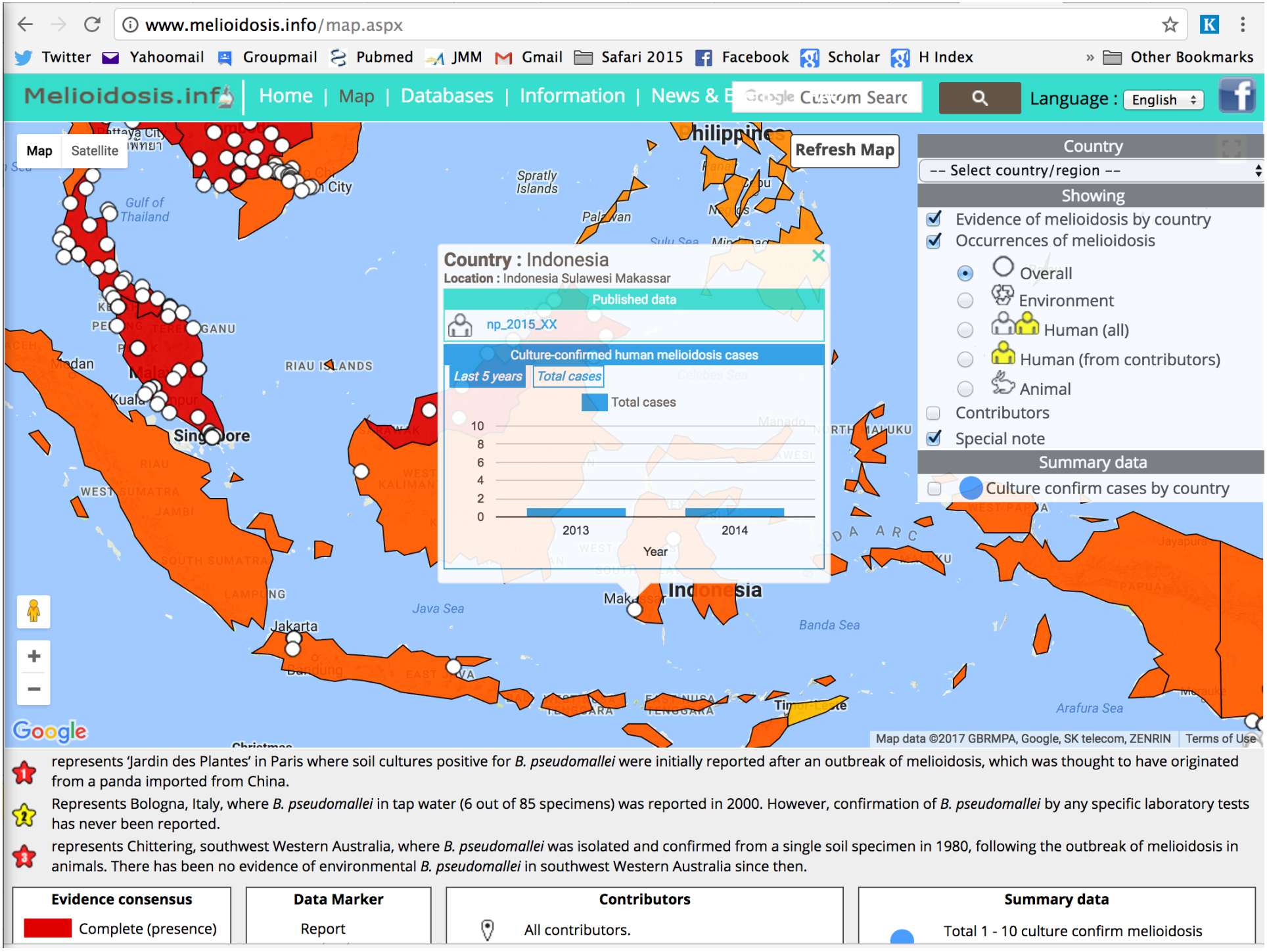

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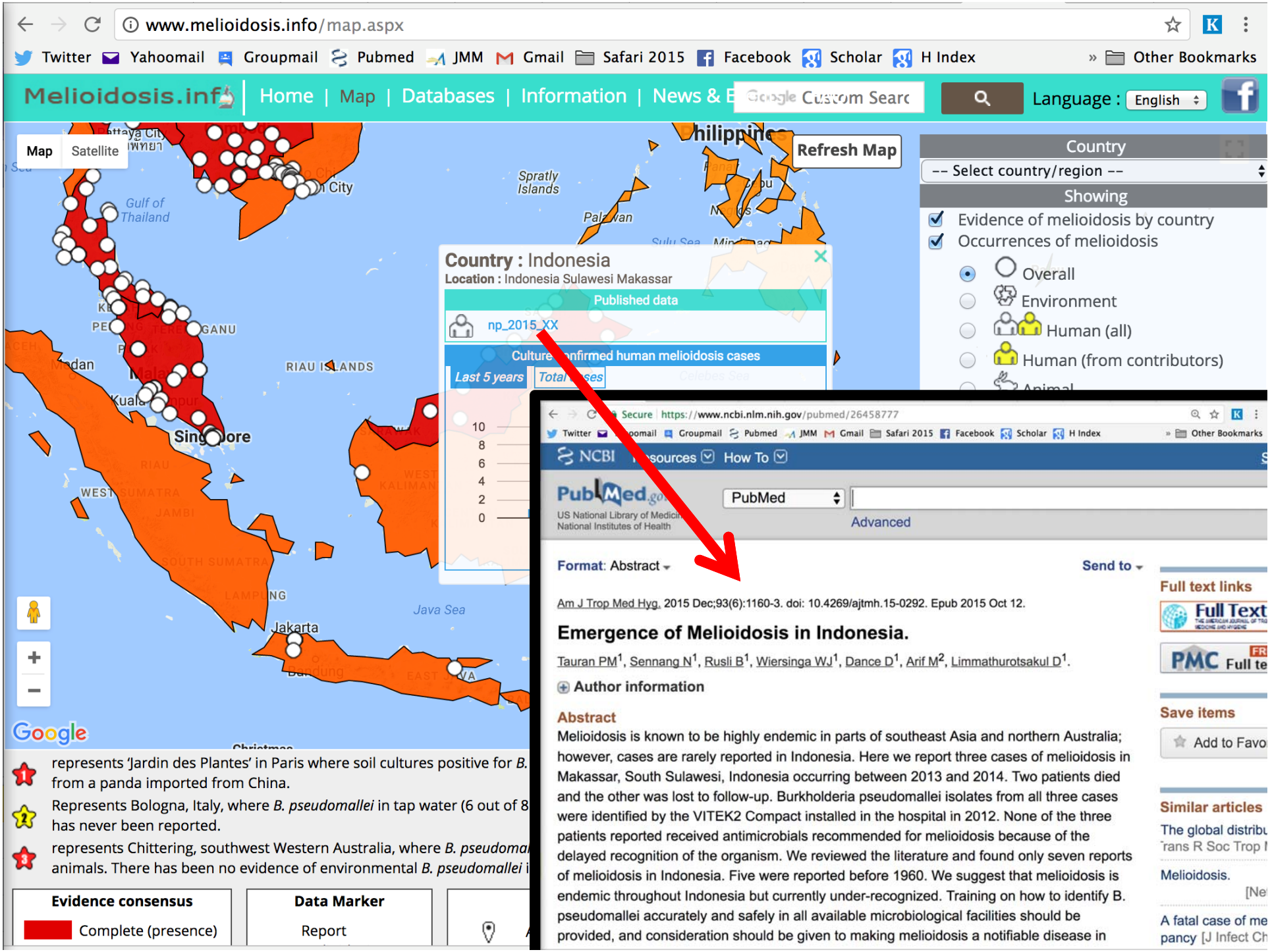
www.melioidosis.info/map.aspx
Melioidosis.info
Home | Map | Databases | Information | News & E
Language : English
Map
Satellite
Refresh Map
Country
-- Select country/region --
Showing
Evidence of melioidosis by country
Occurrences of melioidosis
Overall
Environment
Human (all)
Human (from contributors)
Country : Indonesia
Location : Indonesia Sulawesi Makassar
Published data
np_2015_XX
Last 5 years
Gulf of Thailand
Spratly Islands
Palawan
RIAU ISLANDS
Singapore
Java Sea
Jakarta
Google
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Am J Trop Med Hyg. 2015 Dec;93(6):1160-3. doi: 10.4269/ajtmh.15-0292. Epub 2015 Oct 12.
Emergence of Melioidosis in Indonesia.
Tauran PM, Sennang N, Rusli B, Wiersinga WJ, Dance D, Arif M, Limmathurotsakul D.
Author information
Abstract
Melioidosis is known to be highly endemic in parts of southeast Asia and northern Australia; however, cases are rarely reported in Indonesia. Here we report three cases of melioidosis in Makassar, South Sulawesi, Indonesia occurring between 2013 and 2014. Two patients died and the other was lost to follow-up. Burkholderia pseudomallei isolates from all three cases were identified by the VITEK2 Compact installed in the hospital in 2012. None of the three patients reported received antimicrobials recommended for melioidosis because of the delayed recognition of the organism. We reviewed the literature and found only seven reports of melioidosis in Indonesia. Five were reported before 1960. We suggest that melioidosis is endemic throughout Indonesia but currently under-recognized. Training on how to identify B. pseudomallei accurately and safely in all available microbiological facilities should be provided, and consideration should be given to making melioidosis a notifiable disease in
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www.melioidosis.info/infobox.aspx?pageID=101

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Melioidosis.info | Home | Map | Databases | Information | New | Google Custom Search | Language : English

Raising awareness of Melioidosis

Melioidosis.info is an online-platform for reporting melioidosis cases and for disseminating information of melioidosis for general public, researchers and health policy makers.

Join research network | Report cases | Update institution's information

Upcoming Events

19 Mar 2018 - 21 Mar 2018
European Melioidosis Congress 2018
University of Oxford, UK

29 Aug 2017 - 30 Aug 2017
2nd South Asian Melioidosis Congress
Cinammon Lakeside Hotel, Colombo, Sri Lanka

What is Melioidosis?

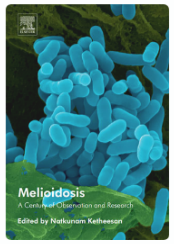
"Melioidosis" is an often fatal infectious disease caused by the environmental bacterium, ***Burkholderia pseudomallei***. Melioidosis is often misdiagnosed because it causes wide range of symptoms which often mimic

https://www.facebook.com/Melioidosis.info/photos/a.370142923028561.83508.300520773324110/1543665122342996/?type=3

Links that you don't want to miss

Posters showing how to [1] look for *B. pseudomallei* colonies on agar plates, [2] identify *B. pseudomallei* and [3] perform drug susceptibility tests. Please click on pictures to get PDFs.

YouTube showing "How to prepare Ashdown agar (selective media for *Burkholderia pseudomallei*)" STEP by STEP !!!



The melioidosis book "melioidosis a century of observation and research" published in 2012 is now accessible free of charge here.

Diagnosis requires high suspicion/recognition by treating physicians and confirmation by isolation of ***B. pseudomallei*** from any clinical specimen such as blood, urine, sputum and pus. However, isolation and identification of ***B. pseudomallei*** require specific microbiology facilities and experienced microbiologists. The mortality rate of untreated patients could be up to 90%, and many die before the diagnosis is made. Thus, the burden of this disease is largely hidden

"Burkholderia pseudomallei" is present in soil and water in the endemic areas, and infection is acquired through skin inoculation or contamination of wounds, ingestion and inhalation.

Melioidosis Fact Sheet from Northern Territory, Australia, 2016

www.melioidosis.info

www.melioidosis.info/infobox.aspx?p

Twitter Yahoomail Groupmail Pubmed

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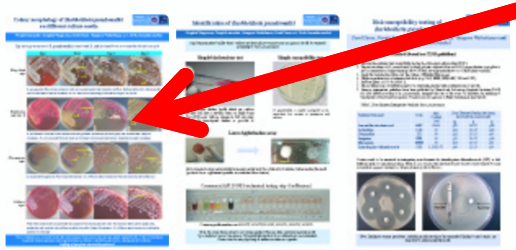
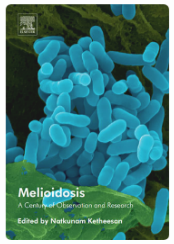


YouTube showing "How to prepare Ashdown agar (selective media for *Burkholderia pseudomallei*)" STEP by STEP !!!



The melioidosis book "melioidosis a century of observation and research" published in 2012 is now accessible free of charge here.

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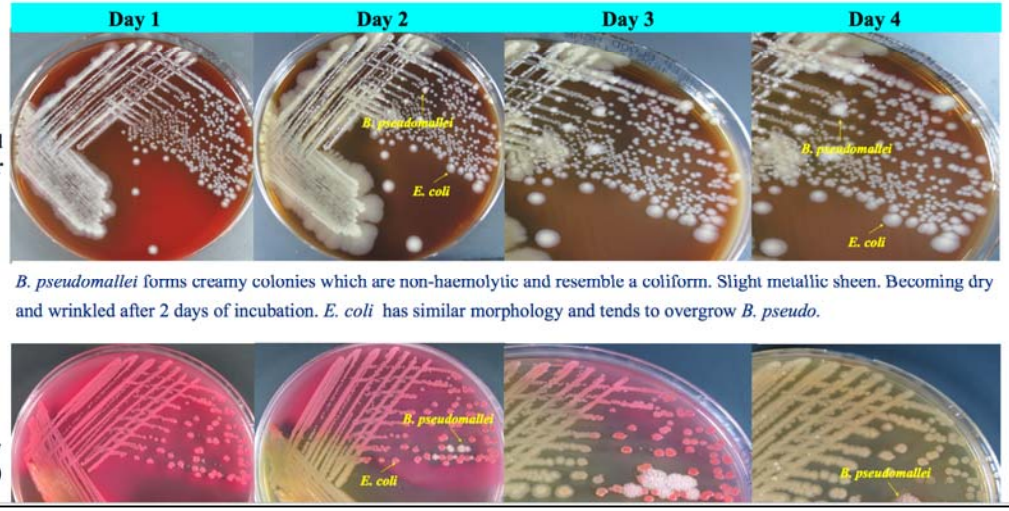
Colony morphology of *Burkholderia pseudomallei* on different culture media

Premjit Amornchai, Gumphol Wongsuvan, David Dance, Vanaporn Wuthiekanun and *Direk Limmathurotsakul*

Typical appearance of *B. pseudomallei* mixed with *E. coli* isolated from non-sterile clinical sample



B. pseudomallei forms creamy colonies which are non-haemolytic and resemble a coliform. Slight metallic sheen. Becoming dry and wrinkled after 2 days of incubation. *E. coli* has similar morphology and tends to overgrow *B. pseudo.*

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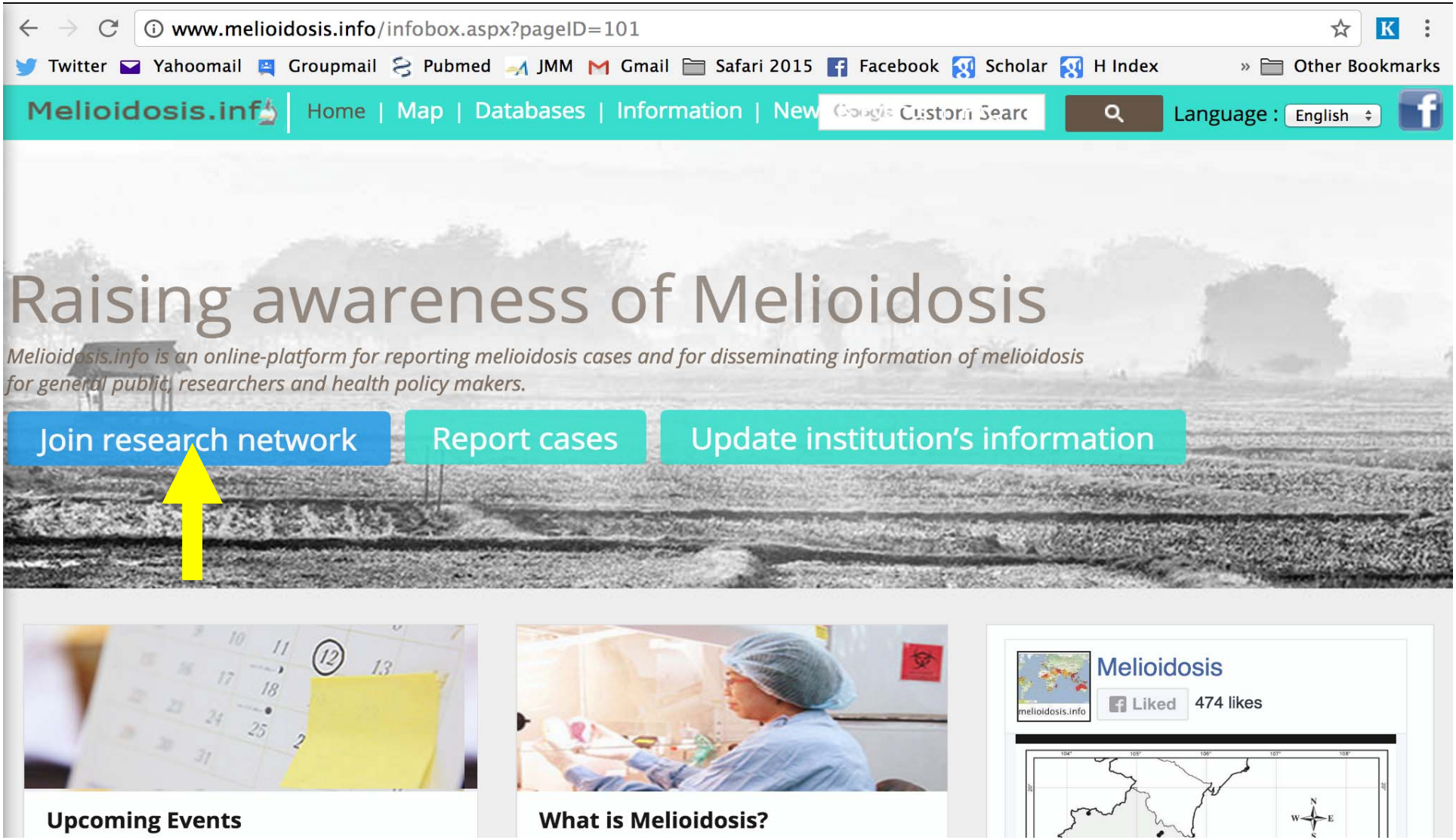
IMS / RCN – the community !!!



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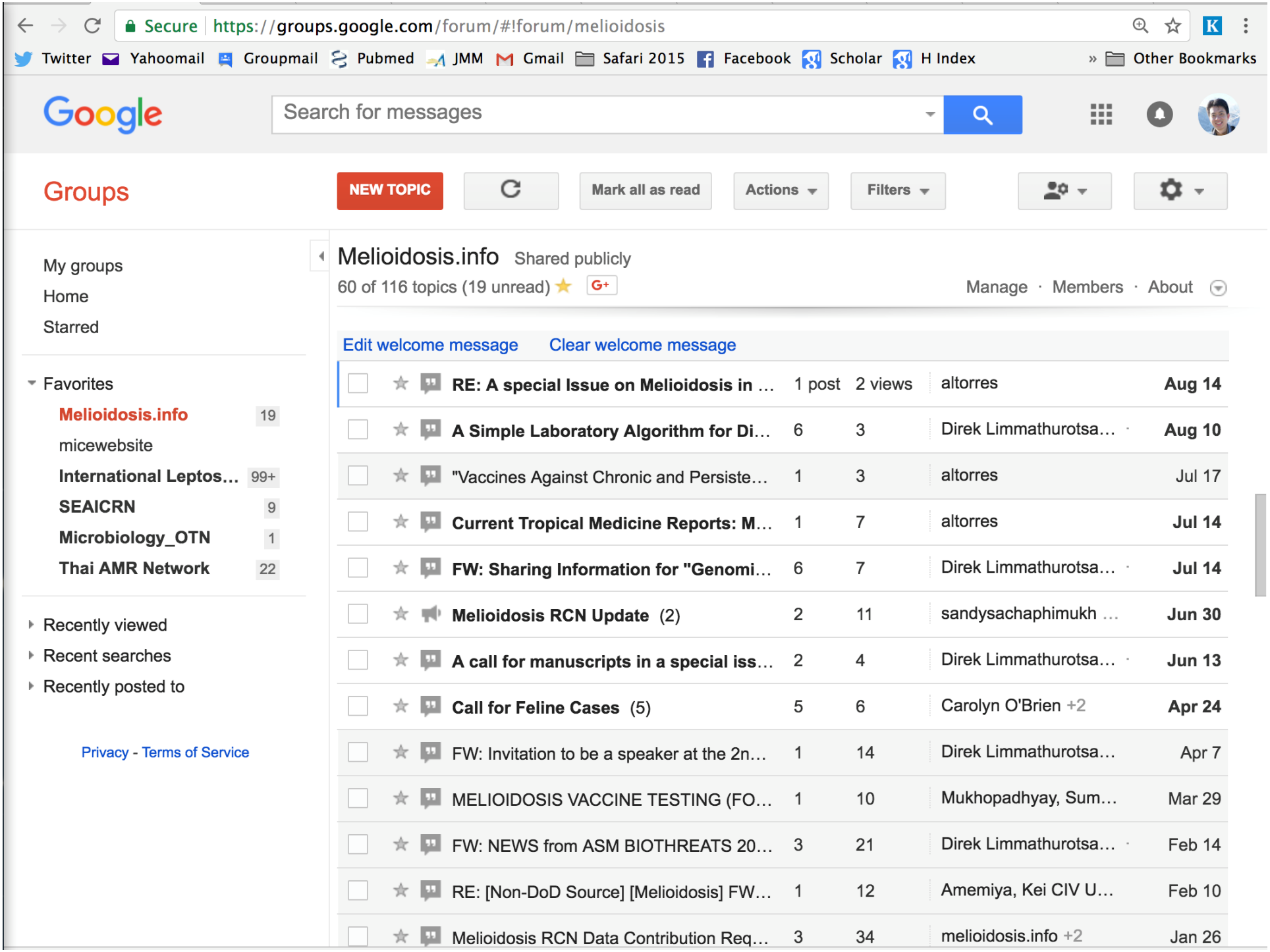
INTERNATIONAL MELIOIDOSIS SOCIETY

Welcome to the International Melioidosis Society. The network is open to anyone with an interest in melioidosis. By joining this Google group, you automatically become a member of the International Melioidosis Society.

Main objective of the International Melioidosis Society [IMS] is to facilitate communication between members.

IMS Committee
- Direk Limmathurotsakul, Thailand [Chair]
- Bart Currie, Australia [Executive member]
- David Dance, UK-Laos [Executive member]
- Joost Wiersinga, Netherlands-Africa [Executive member]
- Dionne Rolim, Brazil
- Ivo Stienmetz, German-Africa
- Natkunam Ketheesan, Australia
- Jay Gee, USA-CDC
- Gan Yunn Hwen, Singapore
- Eric Bertherat, Switzerland-WHO
- Chiranjay Mukhopadhyay, India
- Paul Keim, USA
- Surasak Wongratanacheewin, Thailand
- Sheilla Nathan, Malaysia
- Susanna Dunachie, UK [Core committee & Chair of the EMN2018]
- Brian Angus, UK [Co-Chair; host of the EMN2018]

Objective of the IMS committee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