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JITMM
JOINT INTERNATIONAL TROPICAL MEDICINE MEETING

JITMM 2018, Bangkok, Thailand

Insecticide resistance in mosquito vectors of dengue virus in Indonesia

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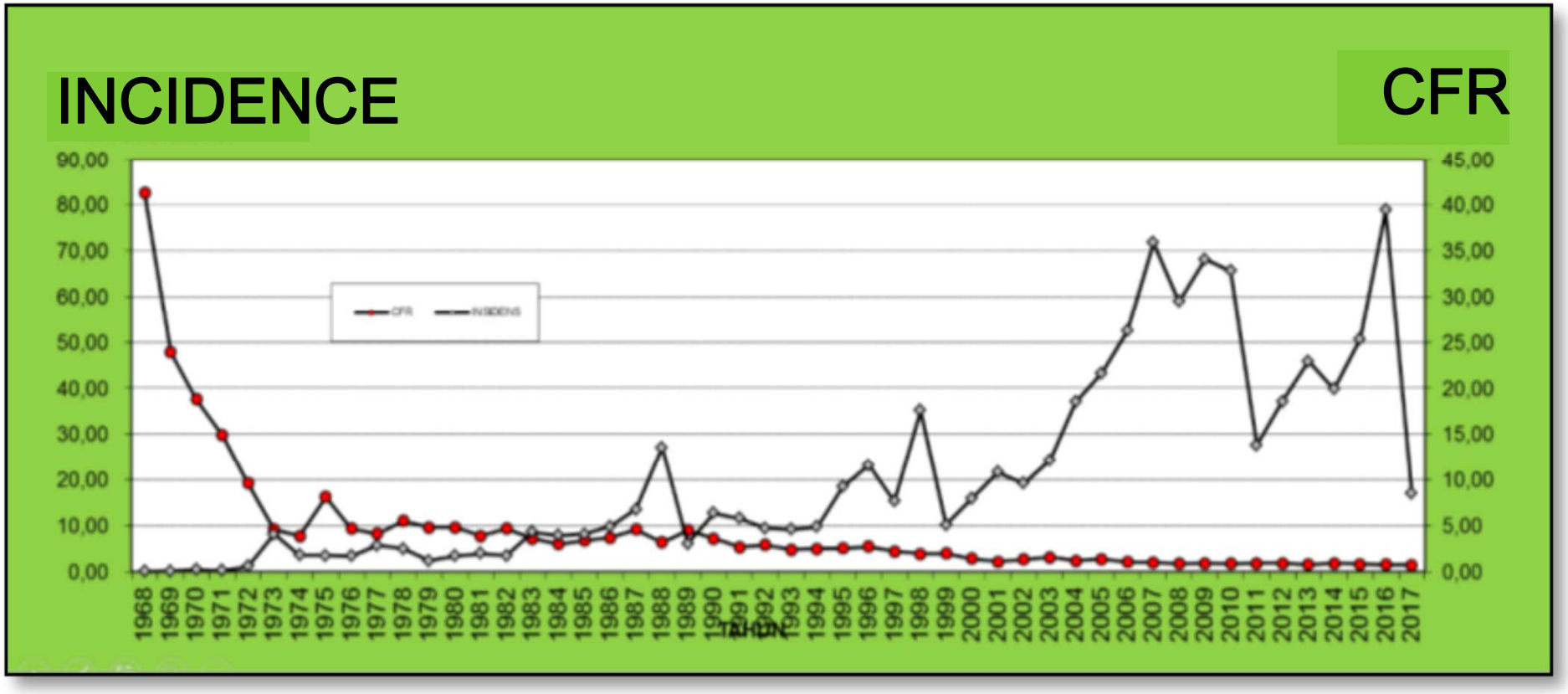
KEY POINTS

- Insecticide resistance has emerged as one of the major problems facing dengue vector control in tropical countries.
- Steadily increasing number of dengue cases despite routine vector control measures demonstrated possible insecticide resistance on vectors.
- Updated database on insecticide resistance status is essential to support insecticide resistance management and operational decisions for effective vector control.

Ministry of Health Republic of Indonesia. 2017.
Moyes CL, et al. ***PLoS neglected tropical diseases***. 2017;11(7):e0005625-e.

DENGUE CASE FATALITY RATE IN INDONESIA



CFR

incidence

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DENGUE SITUATION IN INDONESIA

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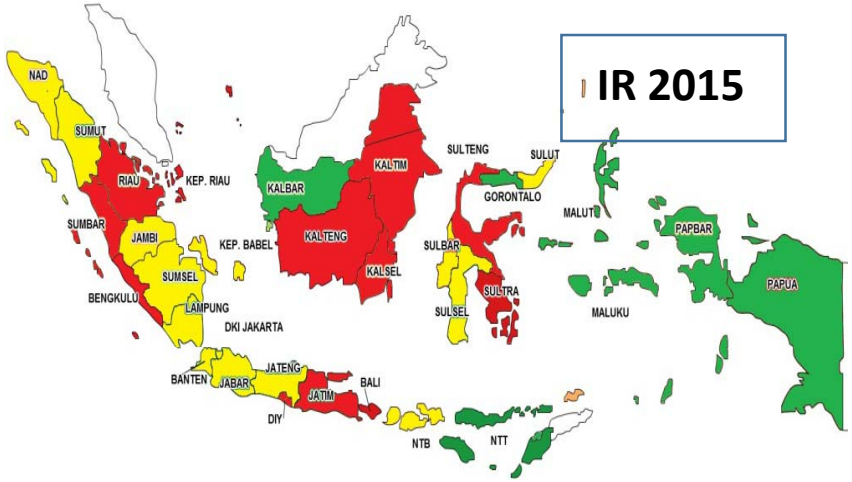

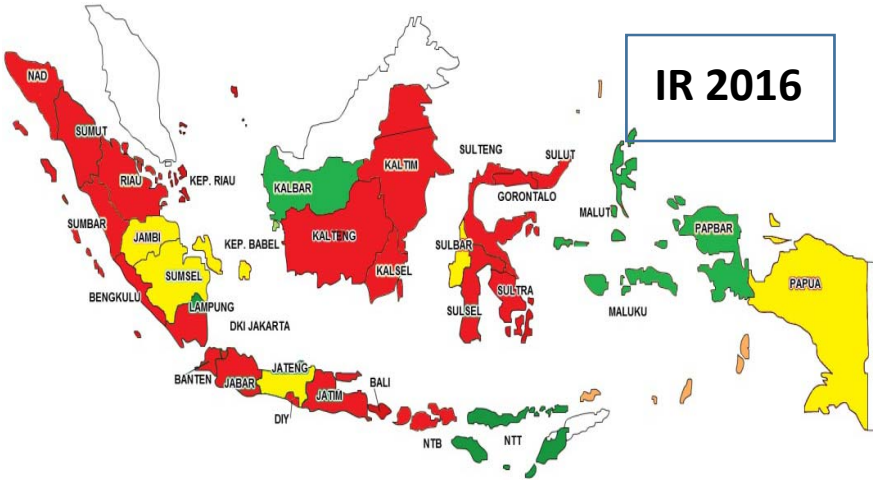

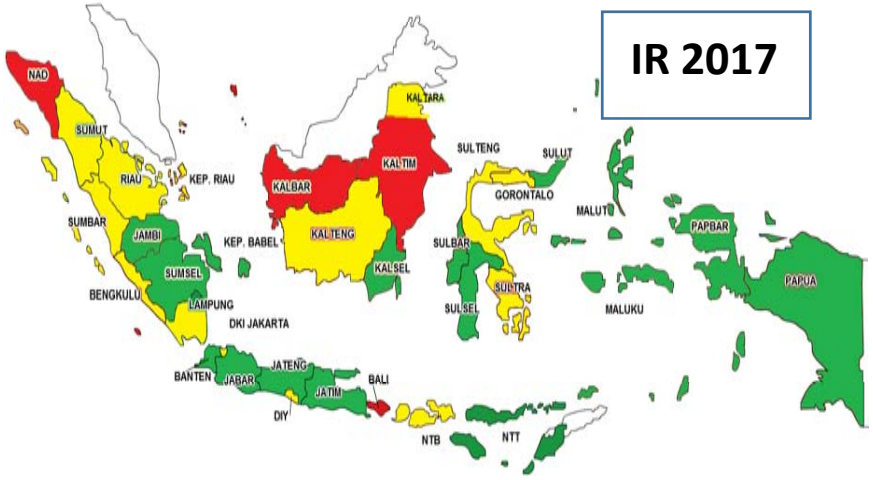

IR: >49 / 100,000 Population

IR: 25-49 / 100,000 Population

IR: <25 / 100,000 Population

Ministry of Health Republic of Indonesia. 2017.

HISTORY

- The control of *Aedes* populations is performed using several strategies, such as environmental management, chemical, biological and integrated control.
- Most extensively practiced control of dengue vectors is the application of chemical insecticides, owing to its high efficacy in regulating the populations with relatively rapid action.
- Due to indiscriminate use of insecticides, mosquitoes have evolved strategies to resist actions of insecticides in their bodies, known as insecticide resistance.

Amelia-Yap ZH, et al. ***Parasites & Vectors***. 2018;11(1):332.
Bharati M, Saha D. ***PLoS One***. 2018;13(9):e0203207.

HISTORY OF INSECTICIDE USE IN *Aedes* CONTROL

Group	Insecticide	Introduction year	Used until	Replaced by
Organochlorine	DDT	1940s	Mid 1960s	Organophosphate and carbamates
Organophosphate	Temephos Malathion Methyl-pyrimifos Fenitrothion	1950s	Currently in use in some parts of the world	Pyrethroids
Carbamates	Propoxur Bendiocarb	1960s	Currently in use in some parts of the world	Pyrethroids
Pyrethroids	Deltamethrin Lambda-cyhalothrin Cypermethrin Permethrin Cyfluthrin	1980s	Currently in use	—

Adapted with modification from:
Manjarres-Suarez A, Olivero-Verbel J. ***Rev Costarr Salud Publica***. 2013;22:68-75.

GLOBAL INSECTICIDE USE TO CONTROL *Aedes* MOSQUITOES

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Region	Country	Insecticides used
Western Pacific	In general	Malathion, pyrethroids
Southeast Asia	Thailand	Temephos, fenitrothion, malathion and propoxur, DDT, permethrin, deltamethrin, cypermethrin
	Vietnam	Organophosphates, pyrethroids
	Malaysia	Temephos, pyrethroids
	Indonesia	Malathion, cypermethrin, lambda-cyhalothrin, deltamethrin, alphacypermethrin, temephos
Africa	Port Suan City	DDT, fenthion, malathion, temephos, permethrin, deltamethrin, lambda-cyhalothrin
Americas	Mexico	DDT, malathion, permethrin
	Brazil	Organophosphates, malathion, fenitrothion
	Argentina	Temephos, cis-permethrin
	Colombia	Malathion, deltamethrin, cyfluthrin, cyhalothrin
Europe	In general	Methoprene, diflubenzuron, pyrethroids

Adapted with modification from:
Manjarres-Suarez A, Olivero-Verbel J. ***Rev Costarr Salud Publica***. 2013;22:68-75.
Medlock JM, et al. ***Vector borne and zoonotic diseases***. 2012;12(6):435-47.

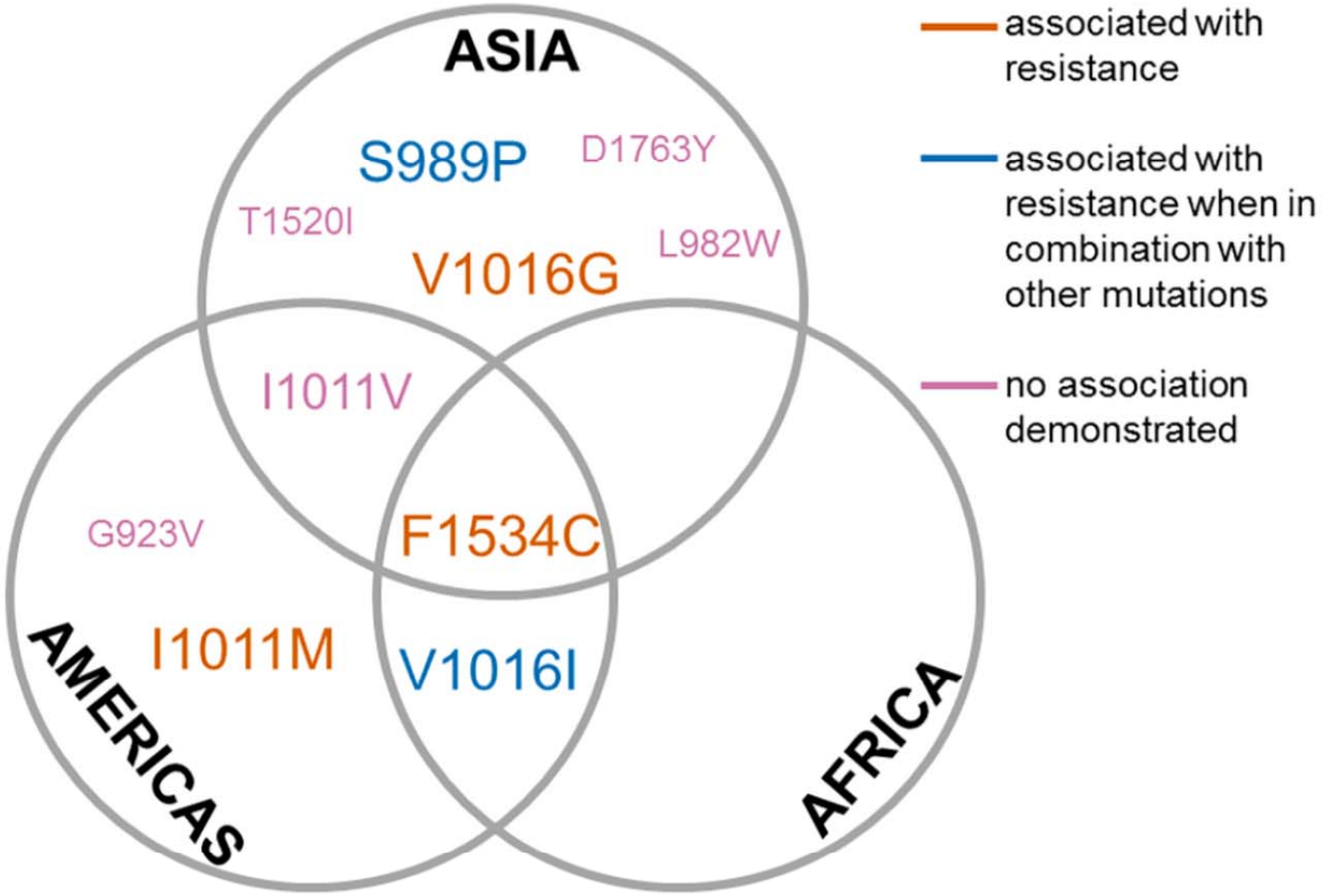
RESISTANCE MECHANISMS

- In general, due to either one, or combination: target-site mutations, metabolic resistance, and, possibly, reduced insecticide penetration.

Group	Resistance mechanisms
Organochlorine	Voltage-gated sodium channel (VGSC) mutations
Organophosphate	Acetylcholinesterase (AChE) mutations, overexpression of P450s, CCEs, and GSTs
Carbamates	AChE mutations
Pyrethroids	VGSC mutations, overexpression of cytochrome P450

David J-P, et al. *Philosophical transactions of the Royal Society of London Series B, Biological sciences*. 2013;368(1612):20120429
Hemingway J, et al. Insect Biochemistry and Molecular Biology. 2004;34(7):653-65.

PYRETHROID RESISTANCE



Moyes CL, et al. *PLoS neglected tropical diseases*. 2017;11(7):e0005625-e.

CURRENT SITUATION IN ASIA

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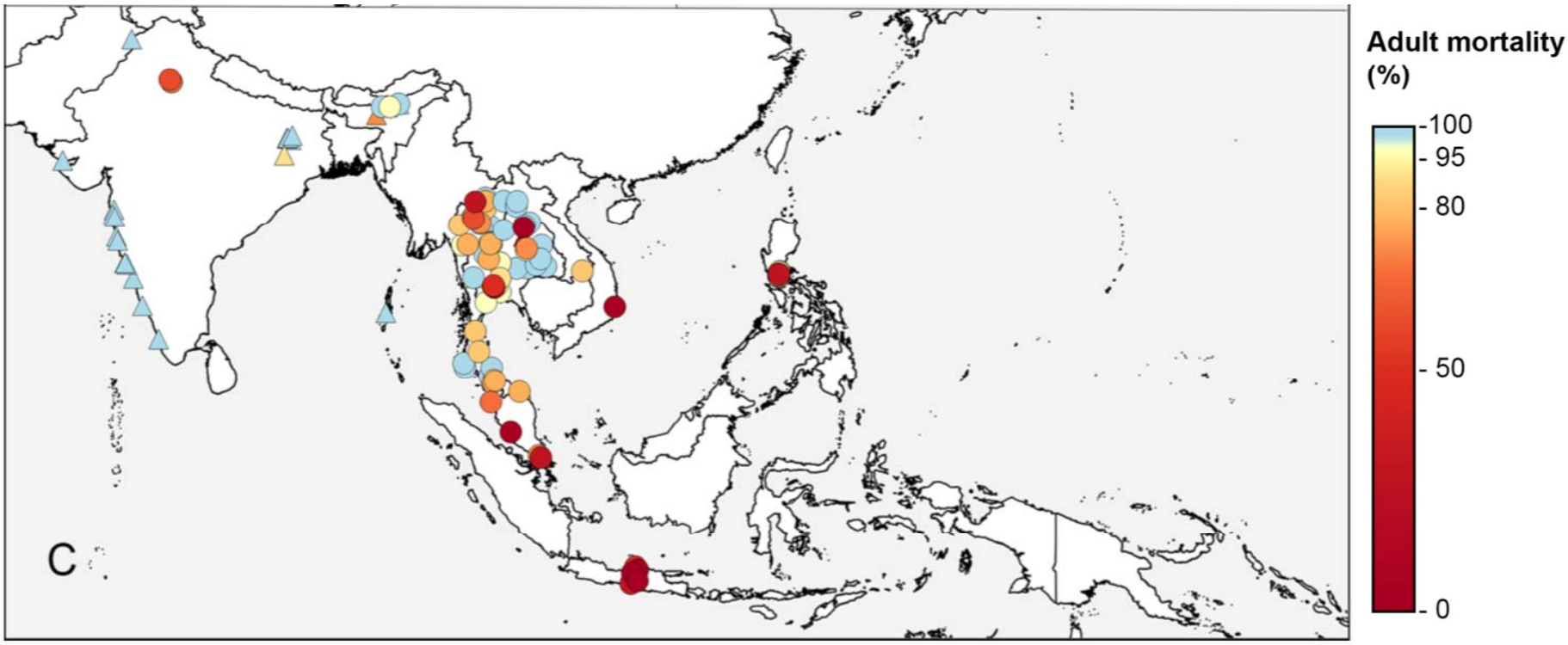

Moyes CL, et al. *PLoS neglected tropical diseases*. 2017;11(7):e0005625-e.

INSECTICIDE RESISTANCE SITUATION IN INDONESIA

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- Insecticide resistance among major dengue vectors has been reported, particularly in pyrethroids and organophosphates.
- In 2009, resistance against 0.8% malathion in *Aedes aegypti* was reported in 13 provinces in Indonesia.
- Subsequently, *Aedes aegypti* resistance against 0.8% malathion and 0.75% permethrin in other 15 provinces was found in 2011.
- In 2015, approximately 76.6% of total 34 provinces in Indonesia have reported *Aedes aegypti* resistance to either pyrethroids and organophosphates.

Ministry of Health Republic of Indonesia. 2017.

RESISTANCE TO 0.8% MALATHION

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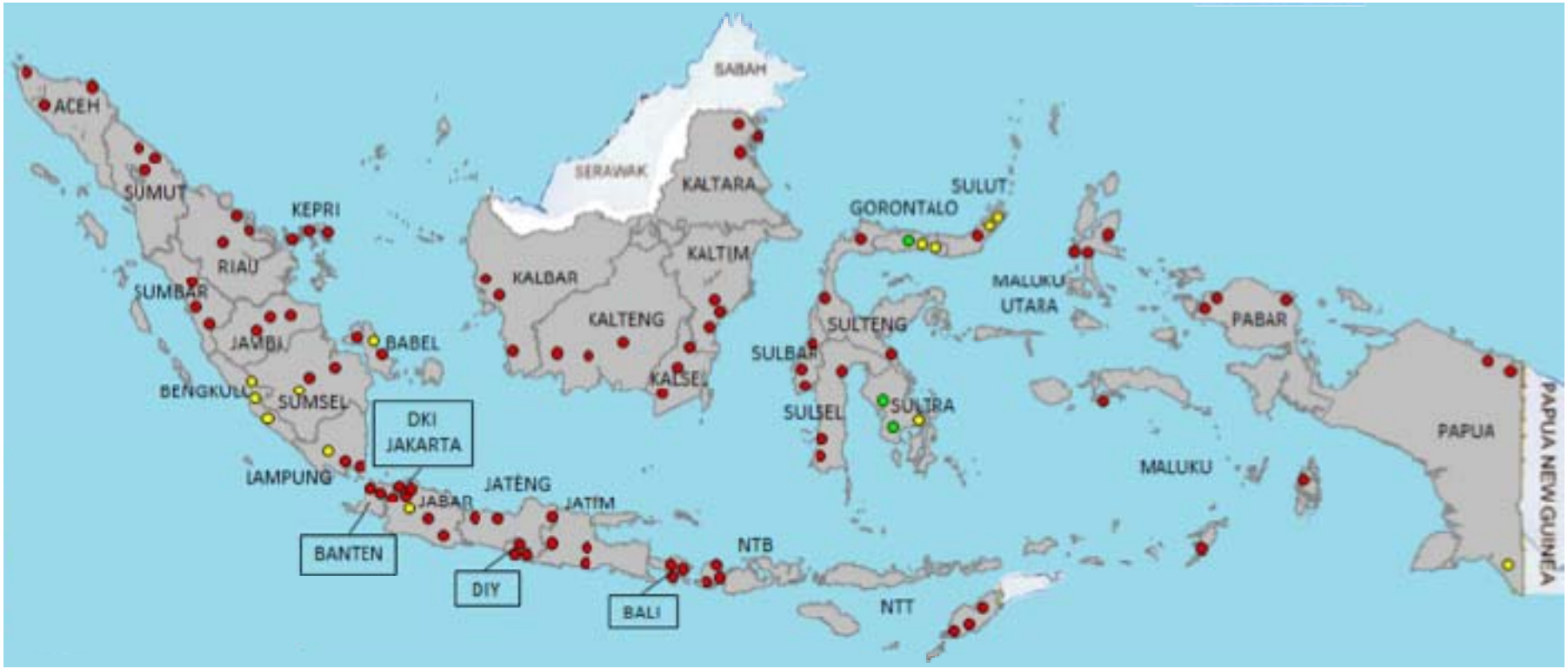

- Susceptible (≥98%)
- Tolerant (90-98%)
- Resistant (<90%)

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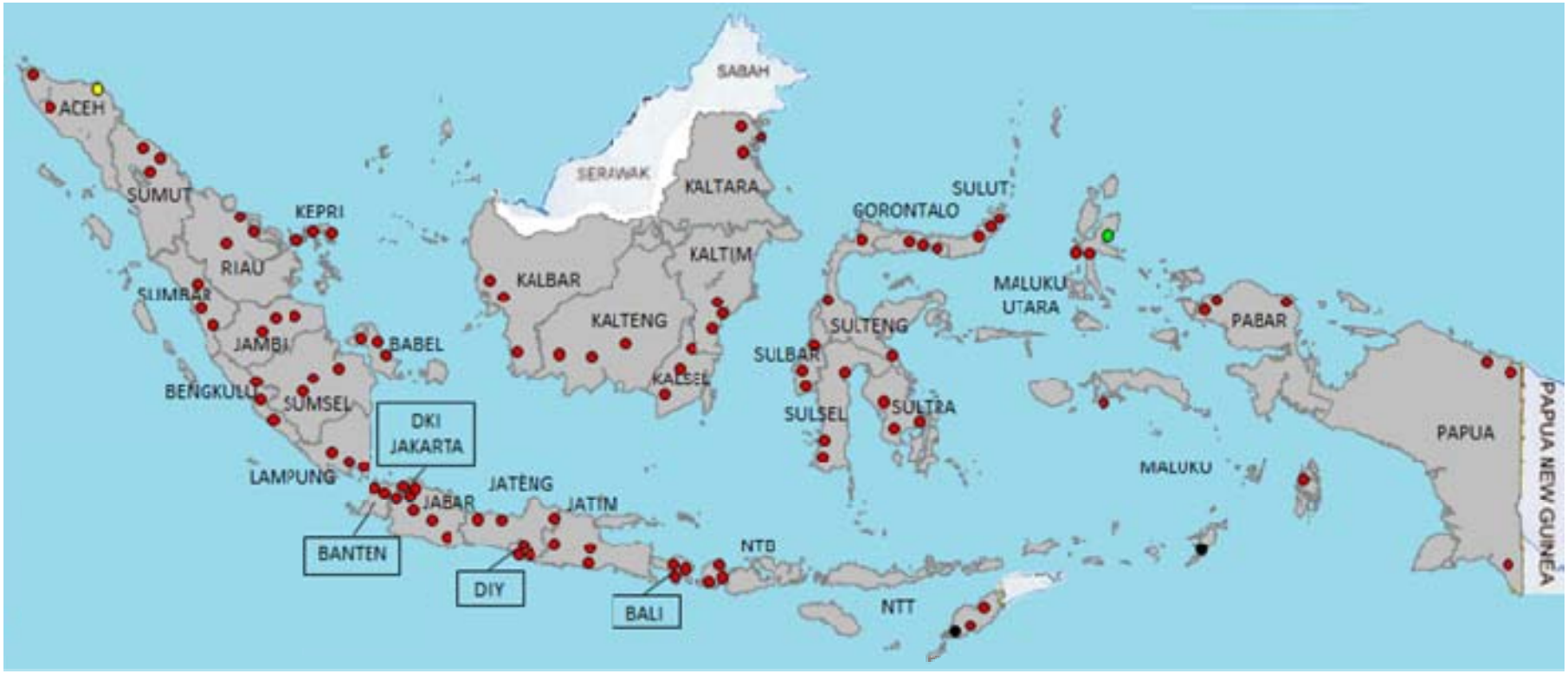
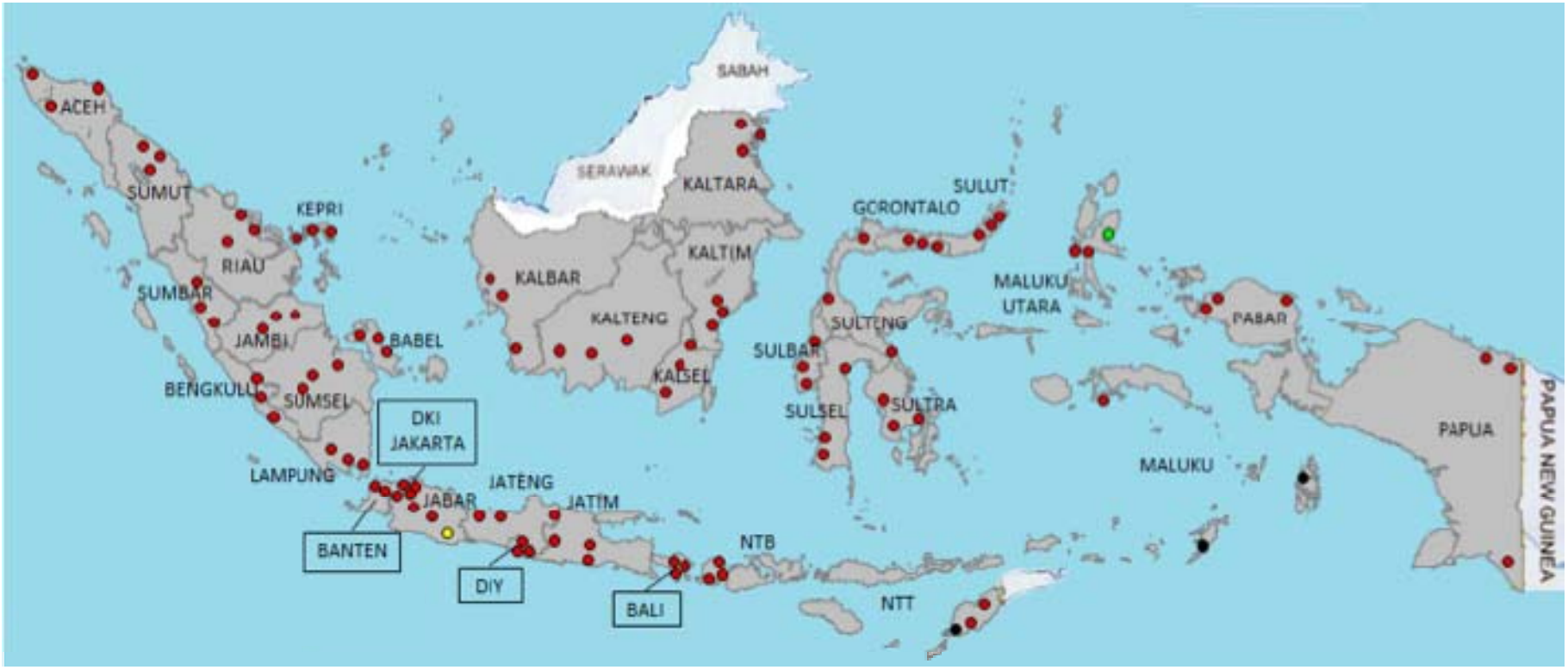
RESISTANCE TO 0.05% CYPERMETHRIN



- Susceptible (≥98%)
- Tolerant (90-98%)
- Resistant (<90%)

Ministry of Health Republic of Indonesia. 2017.

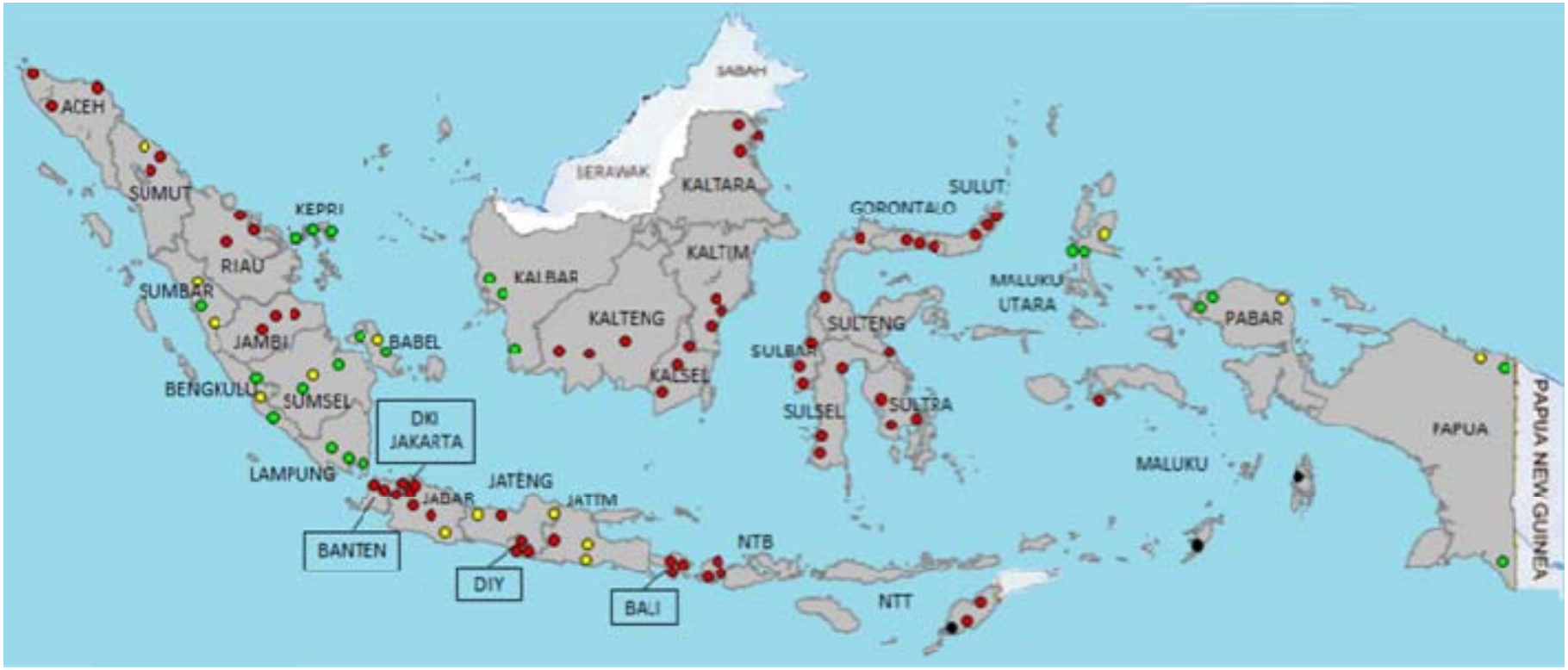
RESISTANCE TO 0.03% LAMBDA-CYHALOTHRIN



- Susceptible (≥98%)
- Tolerant (90-98%)
- Resistant (<90%)

Ministry of Health Republic of Indonesia. 2017.

RESISTANCE TO 0.025% DELTAMETHRIN



- Susceptible (≥98%)
- Tolerant (90-98%)
- Resistant (<90%)

Ministry of Health Republic of Indonesia. 2017.

RESISTANCE TO 0.025% ALPHACYPERMETHRIN

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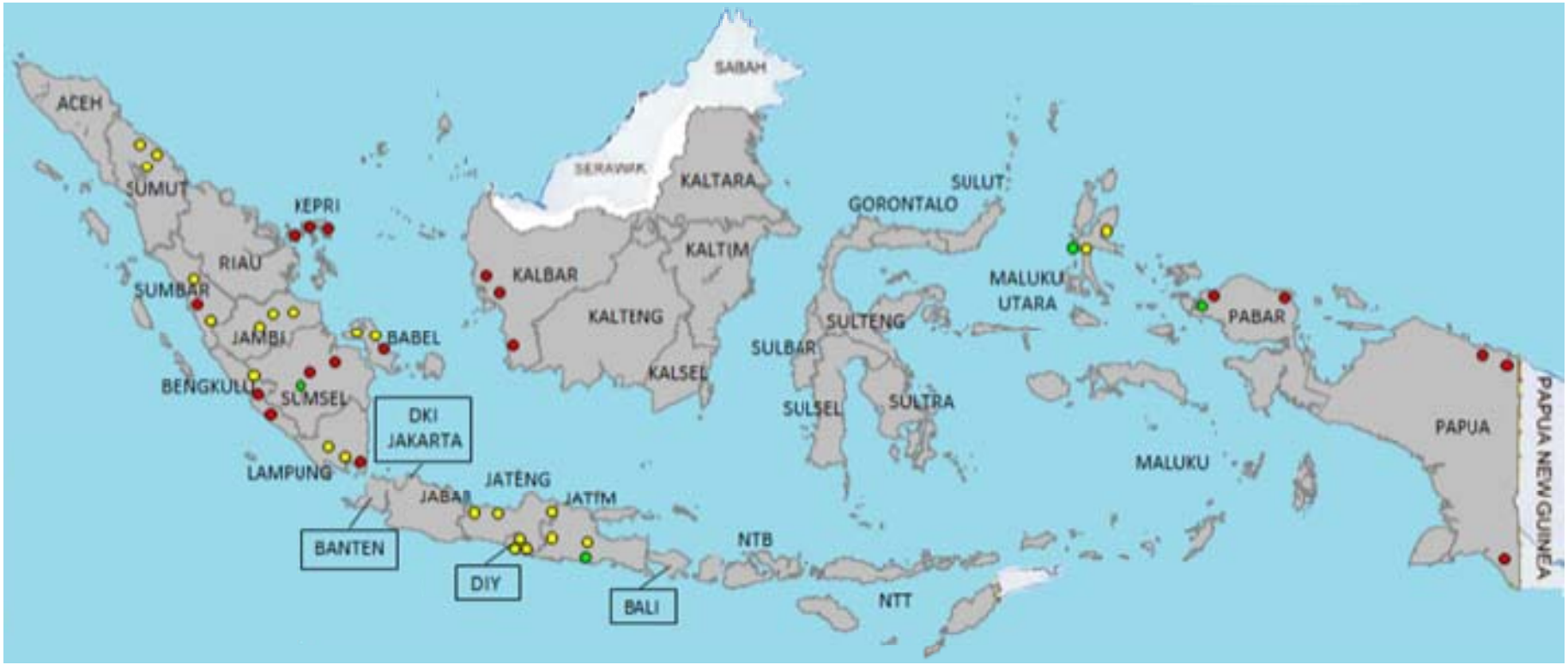

- Susceptible (≥98%)
- Tolerant (90-98%)
- Resistant (<90%)

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RESISTANCE TO 0.02 PPM TEMEPHOS (ORGANOPHOSPHATE)

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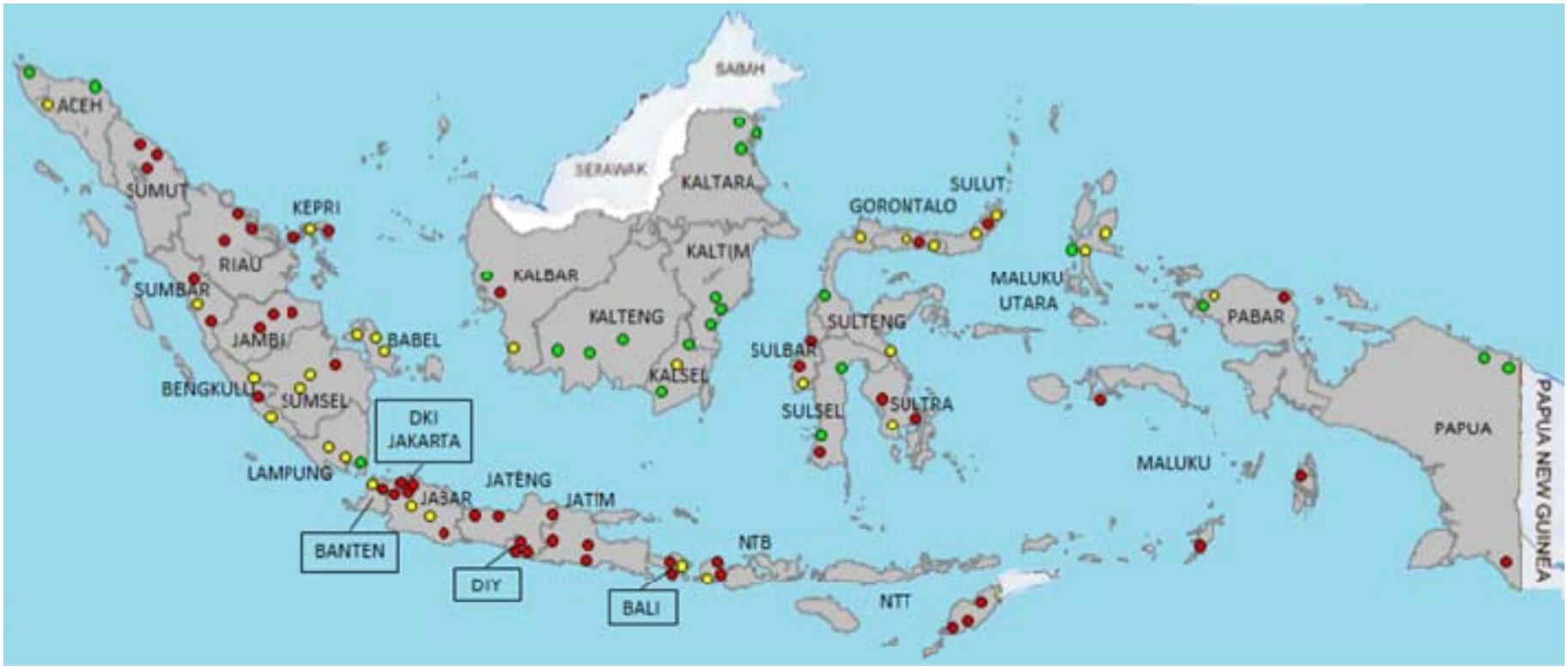

- Susceptible (≥98%)
- Tolerant (90-98%)
- Resistant (<90%)

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CURRENT SITUATION IN INDONESIA

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Susceptible
Tolerant
Resistant
Not tested

M C L D A T

M Malathion
C Cypermethrin
L Lambda-cyhalothrin
D Deltamethrin
A Alphacypermethrin
T Temephos

Ministry of Health Republic of Indonesia. 2017.

WHERE ARE WE NOW?

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- Minimum knowledge on insecticide use, particularly being ignorant towards reading labels containing information on application and doses of insecticides.
- The presence of low-quality insecticide containing fake active compounds or different formulations from the label.
- Ineffective insecticide storage, resistance monitoring, and waste management of insecticide along with insufficient human resources to perform such actions.
- Limited insecticide resistance database and inadequate multi-sectoral regulations controlling insecticide use in dengue vector control program.

LESSONS LEARNED AND WAY FORWARD

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- Periodic monitoring of insecticide resistance status is essential in routine vector control measures.
- Database is important to evaluate widely used insecticides and their field applications for dengue vector control program in dengue endemic area.
- Determination of discriminating dose based on major insecticide resistance situation is also necessary to provide intervention policies in the fight against dengue.
- Commitment of the government and stakeholder by formulating regulations or laws regarding insecticide use in dengue vector control program.

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