Application of a Remoteness Index: Funding Malaria Programs

Beaver, C.,[1] Pontifex, S.,[2] Zhao, Y.,[1] Marston, L.,[3] Bobogare A.,[3]
[1]Institute of Advanced Studies, Charles Darwin University, Darwin, NT, Australia
E-mail: beavercm@gmail.com
[2]Secretariat of the Pacific Community, Noumea, New Calendonia, Email: ScottP@spc.int
[3]National Vector Borne Disease Control Program, Ministry of Health, Honiara, Solomon Islands
Email: abobogare@gmail.com

Abstract
Per capita funding for the malaria control programs in Vanuatu and the Solomon Islands is high compared to other developing countries. This study aims to explore the usefulness of remoteness index to explain the cost differentials, and the possibility of applying such an index to estimate resource requirements in future. To understand some of the key reasons underlying the significant differences, the per capita costs have been compared to the current funding levels for Lao People's Democratic Republic (Lao PDR), adjusted by application of a remoteness and incapacity index (RII). The RII is a measure of remoteness for a particular geographical area. The index reflects differences in population sizes and distances between residents. The measure of remoteness combines the elements of travel distance, time and cost, and quantifies accessibility/remoteness using the latest available population estimates and Geographical Information System based technology. The ratios of Vanuatu and the Solomon Islands RIIs to Lao PDR RII have been used to deflate estimated per capita costs. The above analysis has provided a better understanding of budget estimates for the implementation of current malaria plans in terms of level of funding by objectives, inputs, and source of funds.

1. Introduction

Malaria is a mosquito-borne parasitic disease mostly affecting the poor and vulnerable, primarily in underdeveloped countries (Mouchet et al., 2008). Understanding the cost of malaria control programs is critical for delivering effective and efficient interventions (Hanson et al., 2004). One of the key goals for the International Global Malaria Action Plan was to estimate annual funding needs to deliver effective prevention and treatment for all people at risk of malaria (Roll Back Malaria Partnership, 2008). The national malaria control programs in Vanuatu and the Solomon Islands are characterised by a combination of intensified control and progressive malaria elimination that will be funded through a consolidated budget (World Health Organisation (WHO), 2009). Funding sources are the country budgets, the Global Fund, AusAID, WHO and in the case of the Solomon Islands, Rotary Against Malaria. In Lao People's Democratic Republic (Lao PDR), the malaria control program is characterised as an intensified control program. Malaria control programs are multidisciplinary in nature and include case management, diagnosis, prevention and surveillance (monitoring and evaluation) activitites. The approach taken varies substantially across different stages of malaria control (Roll Back Malaria Partnership, 2008). The costs also vary substantially between countries and regions (Kiszewski et al., 2007). In 2006, most countries in Asia-Oceania region had an annual average cost US$1.16 per person, compared with the global average of $2.16. The estimated per capita costs for Vanuatu and the Solomon Islands were $4.69 and $4.41 respectively, almost quadrupling the regional average and at least doubling the global average. The main cost drivers for the country differences are believed to be a combination of economies of scale and scope, geographical diversity and the impact of international prices. The economies of scale and scope refer to a situation where average costs fall as the volume of activity or the type of intervention increases and the share of fixed costs become low. They are typically related to the size of population at risk, population density, incidence, morbidity, mortality, and number of interventions used simultaneously. For example, Lao PDR (population in 2008: 6.22 million) had much greater population than Vanuatu (0.23 million) and the Solomon Islands (0.52 million) (World Bank, 2009). There are proportionally more international experts working in the malaria program in Vanuatu and the

Solomon Islands than in Lao PDR, and input costs per activity have been found to be higher in both Vanuatu and the Solomon Islands compared to Lao PDR, primarily because of higher air and sea transport costs to the country and within the country. The impacts of greater distance and a scattered population on service delivery need to be carefully considered. Greater distance and a scattered population means longer time and higher costs for travelling, lack of scale economies resulting in inefficiencies and higher personnel costs. The aim of this study is to explore the usefulness of remoteness index to explain the cost differentials in malaria control program by countries, and the possibility in future to apply such an index to estimate resource requirements for malaria elimination. Issues in relation to economies of scale, infrastructure and capacity building are also considered in malaria control settings.

2. Method

The remoteness and incapacity index (RII) has been proposed to assign the degree of remoteness or isolation to a particular area by using geographic and demographic measures (Zhao and Guthridge, 2008). Its definition centres on populations of different sizes and density derived using average distance and number of residents. It also incorporates the concept of incapacity to measure a lack of general infrastructure, such as road, communication, availability of public transport and health services. Such a model of remoteness, which combines the elements of travel distance, time and cost, has been suggested to quantify rural accessibility or remoteness in both Vanuatu and the Solomon Islands using latest available population estimates and Geographical Information System (GIS) based technology. GIS applications are tools that allow users to interpret and analyse spatial data, closely aligned with other relevant information including demographic data, for decision making. They should not be confined to the use of maps. Such an index could also be used to show comparison with other countries on different continents across the world, which are also funding active anti-malaria programmes. RII is a function of remoteness times incapacity such that RII= $a^{1/2}p^{-3/2}$, where a represents the area size and p the population. Incapacity is measured by the reciprocal of the population in thousands. The RII represents the average distance people travel over the capacity for interaction, for example, when a service/activity is provided. The RII has been applied to per capita funding (revised budget estimates). RII was chosen because of its simplicity, availability, ability to aggregate and disaggregate continuously, and ease to measure remoteness for islands (Zhao and Guthridge, 2008).

The average distance between people measured by RII reflects:

- the comparative ease with which people can interact - more opportunities and (ease of) communication both for program management and community engagement;
- the availability of goods, services and skills base required to implement the malaria program, which will have a major impact on labour costs, pharmaceutical and operational costs; and
- the ability and ease of travel and associated costs (roads, public transport and communication are themselves a direct consequence of population numbers and spread).

More complicated measures were developed elsewhere, including Accessibility/Remoteness Index of Australia (ARIA) (Australian Department of Health and Aged Care, 2001) and Territorial Level 3 (The Organisation for Economic Co-operation and Development (OECD), 2007). They are not tested because they are not fully developed world wide. The Commonwealth Grants Commission (CGC) used a similar index, State-ARIA+, to inform the distribution of Commonwealth grants and funds between states/territories in Australia (The University of Adelaide, 2008). RII is a continuous geographical measure of remoteness. The RII values for Vanuatu, Solomon Islands, Papua New Guinea, Australia and Lao PDR were calculated using existing data sets for each country (The Secretariat of the Pacific Community (SPC), 2008). The data sets included most recent population numbers and area measured in terms of square kilometres. The RII provides a simple and logical measure for remoteness that is both intuitive and statistically straightforward. This index is potentially useful for assessing the impact of the lack of access to general goods and services due to remoteness and lack of public transport and communication on the health budget for malaria control.

3. Results

A review of selected countries found that reported malaria budget estimates for Vanuatu and the Solomon Islands are higher per capita than 5 selected developing countries as shown in Table 1. Budget estimates for Vanuatu and the Solomon Islands are from multiple funding sources as noted earlier in this paper.

Estimates for other countries are Global Fund budget estimates (The Global Fund to Fight AIDS, Tuberculosis and Malaria, 2008).

Table 1: Per capita budget estimates for malaria control by selected countries, 2008

Country	Per capita budget estimate ($)
Papua New Guinea	3.22
Mali	0.70
Central African Region	13.20
Lao PDR	8.91
Timor Leste	8.92
Solomon Islands	56.00
Vanuatu	76.00

To understand some of the key reasons underlying the significant differences in per capita costs, the funding for Vanuatu and the Solomon Islands has been compared to the current budget estimate for Lao PDR. Funding estimates at the present time are for 3.5 years for the Pacific Island countries and for 5 years for Lao PDR. Budget estimates for Vanuatu and the Solomon Islands include funding for an intensified elimination program (The Asia Pacific Malaria Elimination Network, 2009) in one province in each country. Lao PDR estimates do not include a similar objective. The remaining 3 objectives from all three country proposals are similar. For comparison purposes budget estimates for the two Pacific Island countries have been adjusted. Funding for the elimination objective (AusAID funded), domestic government contributions and external support services have been deleted from the total budget to produce a revised budget.

3.1 Overall Assessment

The value of RII for Vanuatu was estimated to be 31.04 for Vanuatu, 14.13 for the Solomon Islands and 0.98 for Lao PDR. RIIs were also developed for Papua New Guinea (1.31) and Australia (0.87) for comparative purposes (Table 2).

Table 2: Remoteness and Incapacity Index (RII) for selected countries

Country	Population (100000)	Area (Sq Km)	$a^{1/2}$	$p^{-3/2}$	RII
Vanuatu	2.330	12190	110.4083	0.28112109	31.038
Solomon Islands	5.211	28248	168.0714	0.08406077	14.128
Papua New Guinea	64.739	462840	680.3235	0.00191977	1.306
Lao PDR	62.171	238000	480.4165	0.00203992	0.980
Australia	215.386	7617930	2760.0598	0.00031636	0.873

Table 3: Remoteness and Incapacity Index (RII) adjusted per capita estimates for malaria programs: Vanuatu, Solomon Islands and Lao PDR, 2008

Country	Total budget	Population "at risk" estimates	Per capita budget	Per capita estimates deflated by RII
Vanuatu	$11,122,015	233,000	$46.73	$1.48
Solomon Islands	$23,220,721	521,120	$44.56	$3.09
Lao PDR	$24,628,020	3,600,000	$6.84	-

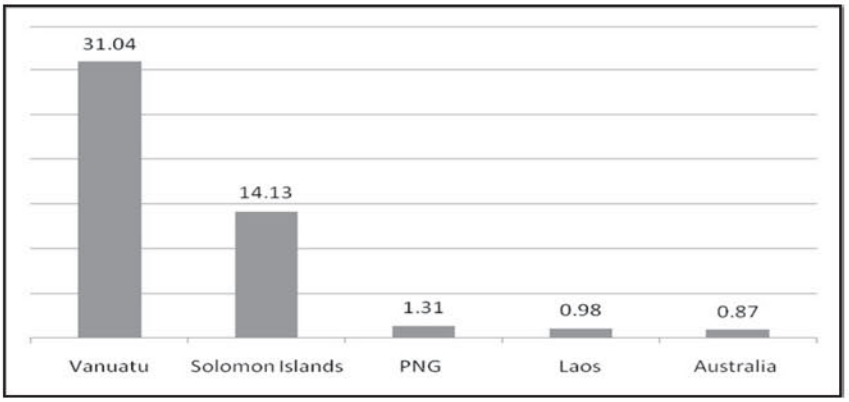

Figure 1: Remoteness and Incapacity Index (RII) for selected countries

It is indicated by the RII that other things being equal, the general service delivery in Vanuatu is over 30 times more resource consuming than Lao PDR and Australia, just because of the population and area size. In the Solomon Islands, service delivery will consume about 15 times more resources than Lao PDR and Australia. To be more precise, a comparison on RIIs based on population size, density and capacity shows that Vanuatu is 31.67 times more remote than Lao and Solomon Islands 14.4 times more remote than Lao PDR. The most remote and incapacitated country (in terms of a measure of remoteness and capacity of its population) is Vanuatu followed by Solomon Islands, then Papua New Guinea, Lao PDR, and finally Australia (Figure 1). The RII can be used to adjust cost estimates. Back in 2003, the CGC applied ARIA+ to adjust general practitioners for primary health care (CGC, 2003). The cost adjustment index utilised in this study is the ratio of the each country's index to the base country index, in this case Lao PDR. The ratio of Vanuatu and Solomon Islands RIIs to Lao PDR RII has been used to deflate estimated per capita estimates (revised budget). The total budget and population numbers and per capita estimates for each country are shown in Table 3. It is shown in Table 3 that the adjusted per capita estimates for Vanuatu ($1.48) and the Solomon Islands ($ 3.09) were less than the actual per capita estimates for Lao PDR ($ 6.80), whereas the actual per capita estimates for Vanuatu ($46.73) and Solomon Islands ($44.56) are over seven times the actual budget estimate for Lao PDR. It is suggested that the significant differences between the actual and deflated per capita estimates are due to the impact of remoteness and incapacity on the cost of service delivery. After taking into account the remoteness and incapacity factors, the budget estimates for Vanuatu and Solomon Islands were not higher than that of Lao PDR.

3.2 Adjusting Budget Estimates for One Key Activity

The cost of the baseline survey in Temotu Province, Solomon Islands, was in excess of $292,792. The Lao PDR budget estimates for a baseline survey for 5 provinces including 13 districts and 49 villages is $58,000. This equates to $11,600 for one province. The cost of the Temotu survey is 25 times that of the Lao PDR survey for one province. If the Temotu survey cost is deflated by the RII for the Solomon Islands then the adjusted cost would be $20,619 (compared to budget estimate for Lao PDR of $11,600). This finding suggests that adjusting cost estimates by the RII can help explain cost differentials between Vanuatu, Solomon Islands and Lao PDR.

4. Discussion: Why do we need a remoteness and incapacity index?

Remoteness is one of the possible explanations for cost differentials. Larger population, higher population density and greater capacity mean economies of scale and scope, which make it easier for a country to deliver malaria control programs. They allow the country to have a more structured workforce, better technology and more low cost goods and services. To the contrary, the reverse will apply if the population is small and population density is low and the per capita costs are higher. Even with the effects of recent strong population growth and urbanization, the vast majority of both the Vanuatu and Solomon Islands population remains rural and remote. A remoteness index can assist in understanding the cost differentials between different target populations. By using RII, we can eliminate the impact of remoteness and population capacity on the budget estimation. The use of urban versus rural definitions in Melanesia does not adequately clearly distinguish between characteristics of urban and rural populations. For example the peri-urban village communities of Ifira, Pango, Mele and Erakor on the outskirts of Port Vila are situated in close proximity to comprehensive urban infrastructure and services, including more ready access to formal sector employment than rural people elsewhere in Vanuatu. While other village settlements are in areas that clearly do not contain a major population centre, the degree of social, economic, and cultural isolation varies widely. In both cases these communities would be classified as rural by the commonly employed definitions without regard to their degree of isolation or remoteness. RII enables us to summarise geographic and demographic data for measurement of remoteness. The factors of geographic diversity, accessibility or isolation such as a lack of transportation, infrastructure, communication and slower spread of technology can be inhibiting factors in the provision of services and development. Distance and the ability to travel are reliant on infrastructure such as roads, transport and communication which are, themselves, a direct consequence of population size. For the most part, persons living in rural areas are very aware of the impact of long distances, as travelling is an integral part of their way of life. However, remote rural areas in Melanesia present many challenges particularly in access to health services. For example, limited, irregular and expensive shipping and few roads have done little for rural populations in the Solomon Islands and large rural populations in Sanma and Tafea provinces in Vanuatu. The main constraint of this study was that it used only

population numbers and area size data to model average cost, and it did not specifically use information about incidence, prevalence and mortality of malaria. It may be argued that the incidence, prevalence and mortality data are more relevant to the volume of health services and the actual costs of service delivery for different types of malaria intervention. Cost adjusted RII can be tested with good quality costing studies. The review has provided a beginning to understanding the potential impact of remoteness and incapacity on the cost of service delivery. The significant differential per capita budget estimates between Lao PDR and the other two countries arises primarily because of economies of scale for Lao PDR and the reverse for the other two countries (a lack of scale economies) as well as geographical diversity and related service incapacity and the impact of international prices. The RII has been used to adjust the per capita estimates for similar objectives for each country. Every health system grapples with the key problems of meeting health care needs for populations in different demographic and geographic environment. GIS provides us with a platform to link health finance with demographic and geographic information. Further work is needed to provide a more robust measure of the differences in costs for both within and between countries. It is important to take account of the country specific service delivery models, the different needs of population groups at any given time within and between countries as well as different cost structures between countries. This will allow for further analysis of the impact of remoteness and incapacity at the village level and the impact on service delivery models and, hence, costs of servicing a population spread over numerous islands, a land mass or living in different terrain. Further, work is also required to explore the impact of distance and price paid for other health services.

5. Conclusion

The above analysis has provided an understanding of expected expenditure for the implementation of current malaria plans in Vanuatu and the Solomon Islands compared to Lao PDR in terms of level of funding by objectives and by inputs, source of funds, and funding level of malaria control compared to other health services.

Acknowledgement

This work was in part funded by AusAID through University of Queensland, Australia

References

Asia Pacific Malaria Elimination Network, 2009, (Brisbane: The Asia Pacific Malaria Elimination Network) http://apmen.org/. Accessed on 12/11/2010.

Australian Department of Health and Aged Care, 2001, Measuring Remoteness: Accessibility / Remoteness Index of Australia (ARIA). (Canberra: DOHA).

CGC, 2003, Non-Inpatient and Community Health Services — Revised. (Canberra: CGC).

Global Fund to Fight AIDS, Tuberculosis and Malaria, 2009, Global Fund Grant Portfolio. (Geneva: The Global Fund to Fight AIDS, Tuberculosis and Malaria) http://www.theglobalfund.org/en/portfolio/. Accessed on 1/06/2009.

Hanson, K., Goodman, C., Lines, J., Meek, S., Bradley, D., and Mills, A., 2004, *The Economics of Malaria Control Interventions*. (Geneva: World Health Organisation).

Kiszewski, A., Johns, B., Schapira, A., Delacollette, C., 2007, Estimated Global Resources Needed to Attain International Malaria Control Goals. *Bulletin of the World Health Organization*, 85, 623-630.

Mouchet, J., Carnevale, P., and Manguin, S., 2008, *Biodiversity of Malaria in the World*. (Paris: John Libbey Eurotext).

OECD, 2007, OECD Regions at a Glance. (Paris: OECD).

Roll Back Malaria Partnership, 2008, *The Global Malaria Action Plan*. (Geneva: RBM).

SPC, 2008, Online Databases. (Noumea: SPC). http://www.spc.int/. Accessed on 1/06/2009.

University of Adelaide, 2008, State Accessibility / Remoteness Index of Australia Plus (SARIA+). (Adelaide: GISCA).

World Bank, 2009, Countries and Economies. (Washington: The World Bank). http://data.worldbank.org/country/. Accessed on 9/12/2010.

World Health Organisation, 2008, Malaria Country Profile 2009. (Geneva: WHO) http://www.who.int/malaria/publications/country-profiles/en/index.html. Accessed on 1/06/2009.

Zhao, Y., Gutheridge, S., 2008, Rethinking Remoteness: A Simple and Objective Approach. *Geographical Research*, 46, 413–420.