Geospatial Health 6(2), 2012, pp. 295-298

The Health Resources Allocation Model (HRAM) for the 21st century

Nicolas Maire[1,2], Michael Hegnauer[1,2], Dana Nguyen[1,2], Lucas Godelmann[3], Bernadette Peterhans[1,2], Axel Hoffmann[1,2], Don de Savigny[1,2], Marcel Tanner[1,2]

[1]*Department of Epidemiology and Public Health, Swiss Tropical and Public Health Institute, P.O. Box, CH-4002 Basel, Switzerland;* [2]*University of Basel, P.O. Box, CH-4003 Basel, Switzerland;* [3]*Hölzlistrasse 46, CH-4102 Binningen, Switzerland*

Abstract. The Health Resources Allocation Model (HRAM) is an eLearning tool for health cadres and scientists introducing basic concepts of sub-national, rational district-based health planning and systems thinking under resources constraint. HRAM allows the evaluation of resource allocation strategies in relation to key outcome measures such as coverage, equity of services achieved and number of deaths and disability-adjusted life years (DALYs) prevented. In addition, the model takes into account geographical and demographic characteristics and populations' health seeking behaviour. It can be adapted to different socio-ecological and health system settings.

Keywords: spatio-temporal visualization, health systems and planning, resources allocation, modelling, teaching, Tanzania.

Link: https://www.youtube.com/watch?v=Pz7O47MnWCE

Background

The optimal allocation of resources for health in a resource-constrained context requires critical planning. Moreover, decision-makers have to take a number of factors into account, including the local disease pattern, the socio-political setting, and the existing health system and infrastructure. The eLearning tool Health Resources Allocation Model (HRAM), developed more than 15 years ago (Godelmann, 1995), is designed for use in courses on health systems planning. The tool supports course facilitators in the evaluation of resource allocation strategies proposed by course participants as part of an exercise on establishing district intervention priorities under the constraints of a limited budget. HRAM provides the basis for finding the optimal deployment of district health facilities, improvement of health system quality in terms of different metrics of success, and the determination of constraints and bottlenecks. The model evaluation is set in a baseline scenario, which describes a district in terms of demography, basic epidemiology as well as existing road network. In addition, the health resources that can be deployed are characterized by attributes like capacity, level of treatment and annual costs. Both baseline information and allocation patterns are spatially explicit, which is crucial because the predicted performance of an allocation plan is assumed to depend on the willingness and ability of patients to travel in search for care (Box 1).

The model is based on a primarily curative medicine-oriented cardboard game by Folmer (1987) that was developed into a computer-based teaching/training tool for introducing and conceptualizing district health planning by Godelmann (1995), as part of a PhD in epidemiology at the Swiss Tropical Institute (predecessor of the Swiss Tropical and Public Health Institute (Swiss TPH), an institute associated with the University of Basel, Switzerland). This tool has been successfully used for many years in courses at the Swiss TPH, University of Geneva, Switzerland, at the Chulalongkorn University, Bangkok, Thailand and within the network of the Swiss School of Public Health+ (SSPH+), among others. HRAM aims at introducing the concepts of health planning and resources allocation under resource constraints through blended learning with guided group work on health planning in a real world situation (an existing district with respective databases) and computer-based assessments of the health planning decisions made by the group. The successful use of the planning tool by

Corresponding author:
Nicolas Maire
Department of Epidemiology and Public Health
Swiss Tropical and Public Health Institute
P.O. Box, CH-4002 Basel, Switzerland
Tel. + 41 61 284-8130; Fax +41 61 284-8105
E-mail: nicolas.maire@unibas.ch

Box 1. Spatially explicit model components.

HRAM provides a method for the evaluation and quantification of the performance of a health system in terms of coverage for preventive and curative health care, death prevention and DALYs averted (Fig. 1). Spatially explicit characteristics such as geo-coordinates of villages, the road network and the population distribution constitute the fundamental components of the model. Once the model has been initialized with the static data of a specific scenario, an allocation strategy can be fed into it by introducing a dynamic list of geo-located health resources.

Assuming an ideal referral system, high-level health facilities are reserved for those patients who suffer from the most severe diseases. This implies that every patient first visits a referral facility near his or her home town to be transferred to a facility guaranteeing adequate treatment. Finding the best allocation strategy means obtaining the optimal balance between maximal treatment coverage and under-utilization of capacity. When running model calculations based on different referral systems, the patient's willingness to travel is a crucial aspect of capacity utilization and treatment coverage. The model assumes that a number of factors influence a patient's health-seeking behaviour. It evaluates actual distance of a patient to an appropriate health facility taking into account the condition of infrastructure such as roads and communication facilities. In addition, factors such as disease severity, capacity level and the availability of transport affect the willingness to travel. Different decay functions of the probability of seeking care were tested (Godelmann, 1995) but the current model applies basic probit-functions for all diseases and conditions with the only modifier being the perceived severity of disease.

Predictions of treatment coverage and proportion of deaths and DALYs prevented are generated based on the district-, division- and village-level. On each of these levels, an additional set of output parameters is available that allows a thorough analysis of the situation at the specific location. This also facilitates the comparison of systems performance and capacity utilization between different villages and divisions. A further aspect of model predictions is the exploration of the actual investment into different geographical areas based on the distribution and use of allocated facilities. The model provides feedback on the balancing of costs between different regions and results on the investment per deaths and DALYs averted and the discrepancies between different locations. Consequently, the model output allows the introduction and further the understanding of equity principles of health planning by illustrating common trade-offs.

hundreds of graduate and postgraduate students in public and international health is consistently reflected in course evaluations and the feedback received by the course centre at Swiss TPH. The basic concept of the model, its components and outcome measures are shown in Fig. 1. To ensure that HRAM can continue to be used with modern software and computer technology, HRAM has now been updated and extended (Box 2). It has also been adapted to (i) the prevailing concepts of decentralized health planning and (ii) a more individual as well as more comprehensive, computer-based learning tool.

Disability-adjusted life years (DALYs) have been widely adopted as a measure of burden of disease, injuries and risk factors (Murray and Lopez, 1996b). To reflect this, "DALYs averted" were added to the already existing endpoints for health systems performance in the model (treatment coverage and deaths prevented). This required an extension of the baseline scenario data structure, to include age- and sex-specific incidence rates and data for disease duration and disability weights in treated and untreated forms. The DALY calculation uses standard formulae for age-weighting and time-discounting. The model calculates the impact of treatment on case fatality, reflected by the reduction of years of life lost (YLLs), and the effect of treatment on disease duration and disability, quantified by the number of "years lived with disability (YLDs) averted". Along with the number of "DALYs averted", the number of avoidable DALYs can be calculated; thus, allowing the evaluation of an individual's allocation strategy.

The most popular baseline scenario used in teaching is set in the Kilombero district in Tanzania. As the original baseline data (compiled and established in the late 1980s) was outdated, it became necessary to update it to reflect the current demography, infrastructure and disease pattern of the district. Epidemiological data were taken from various journal articles and studies. Current demography data was taken from Tanzanian village statistics (The Government of Tanzania, 2011), while Google Earth and Africa Data Sampler (World Resources Institute, 2011) provided much of the information on the current infrastructure. The age-specific incidence rate data necessary to support DALYs as endpoint was taken from the National Burden of Disease Toolkit provided by the World Health Organization (WHO) for Tanzania. The episode duration data was obtained from Murray and Lopez (1996a), whereas the Global Burden of Disease 2004 update provided the disability weights (WHO, 2004). Economic data were taken from the Tanzanian National Health budget mainly drawing on the extensive work around the Tanzanian Essential Health intervention Programme (de Savigny et al., 2008).

Outlook

HRAM provides a novel approach for teaching and training of health planners and health systems specialists and is the only comprehensive tool for (i) rational, sub-national health planning under resources con-

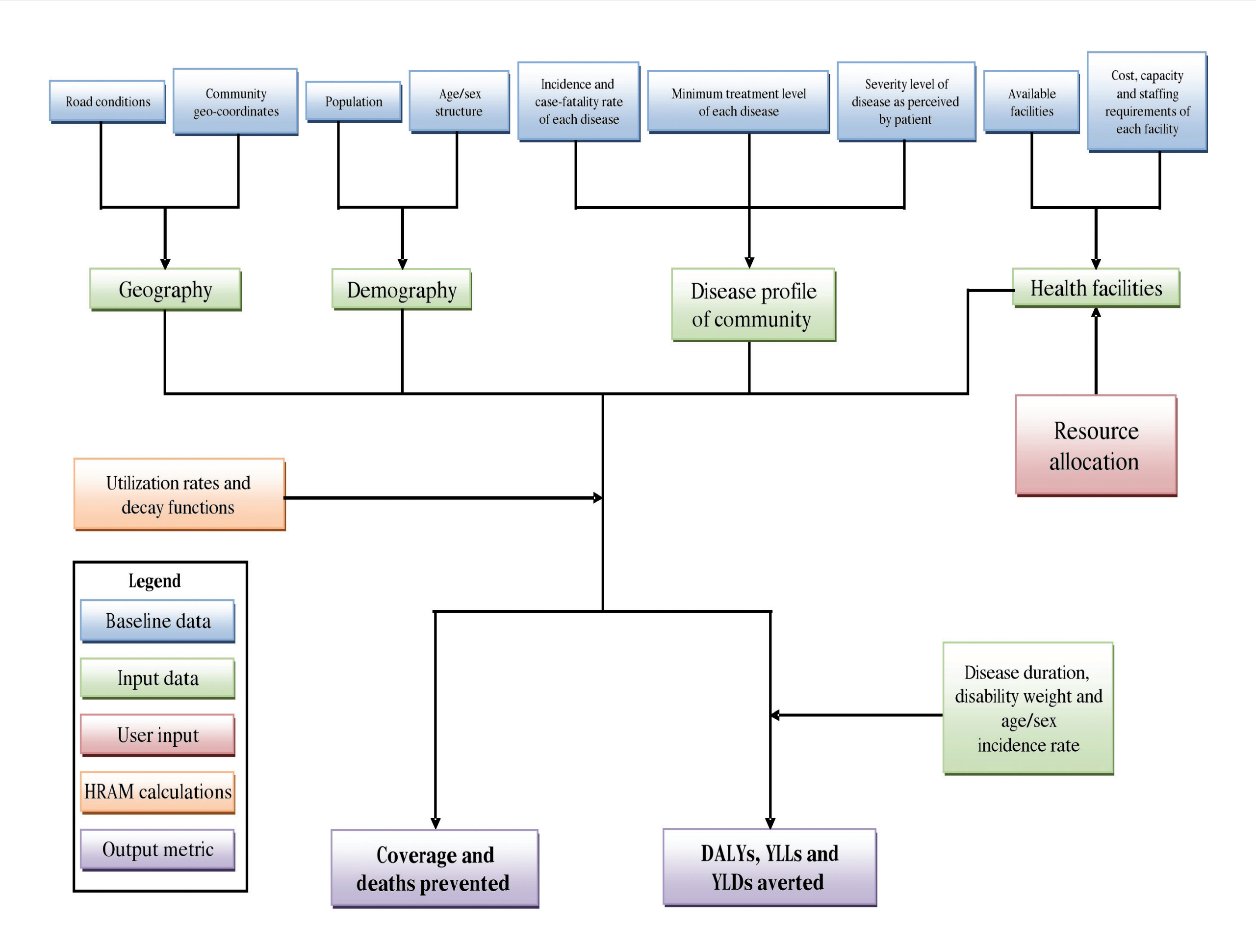

Fig. 1. Basic structure of the HRAM

Box 2. Model implementation and underlying technologies.

The original HRAM was implemented to run on the DOS operating system, which is no longer supported. The HRAM core model has therefore been re-implemented in the Java programming language to ensure that the software can continue to run on personal computers. It is based on existing scenario data and reproduces the results of the former implementation. The implementation has been designed to be highly generic and easy to configure with respect to the underlying scenario data such as geographic, demographic and epidemiological data. These data are stored in a central scenario XML file. Complying with certain object-orient design patterns like 'Visitor' and 'Dependency Injection' patterns, the software allows for a dynamic invocation of several 'calculation policies'. That means calculations can be run simulating different models from simple to more complex referral health system models.

The HRAM software comprises two complementary modules. It is available as a standalone batch utility tool that can be deployed to various computer operating systems with a Java Runtime Environment installed and can be used in settings where no Internet access is available. The second module consists of a Web 2.0 application, hosted in the Google App Engine, which provides functionality for visualizing scenario data on maps and to generate various types of reports and charts to illustrate different aspects of the model predictions. It has been implemented using the Google Web Toolkit technology accessing the interfaces of Google Visualization and Google Maps APIs. This approach allows a user to run the model in a web browser without the need to install additional add-ons or plug-ins. By improving the workflow and the presentation of simulation results (numeric results, graphs and charts), workload on facilitators during a course could be reduced considerably. This includes detailed results on a village level, comprehensive information regarding disease patterns, an overview of capacity utilization of the allocated health structures and facilities, and feedback on equity and cost-effectiveness achieved through the planning decisions. All input databases are flexible in order to facilitate the incorporation of new districts (i.e. the model is set-up to understand health planning at subnational level, and hence the units for planning chosen in any country should correspond to an administrative unit, typically a district within a decentralized health system) or the modification of existing ones in accordance to the choices of the advanced users from any part of the world.

straints and/or (ii) the generation of relevant health systems research in a given socio-ecological setting. Adaptation to, and validation in, more different settings will not only increase its use but also lead to a continuous improvement iteratively with the changing environment and priorities of global health development.

References

de Savigny D, Kasale H, Mbuya C, Reid G, 2008. Fixing health systems. International Development Research Centre, Canada.

Folmer HR, 1987. Simulation game in health resource allocation. Health Policy Plan 2, 189-190.

Godelmann L, 1995. Health planning under resource constraints: a computerised model for health planning at district level. PhD thesis, University of Basel, Switzerland.

Murray CJL, Lopez AD, 1996a. Global health statistics: a compendium of incidence, prevalence, and mortality estimates for over 200 conditions. Available at: http://espace.library.uq.edu.au/view/UQ:113991 (accessed on 7 January 2012).

Murray CJL, Lopez AD, 1996b. Estimating causes of death: new methods and global and regional applications for 1990. Geneva: World Health Organization.

The Government of Tanzania, 2011. National website of the United Republic of Tanzania. Available at: http://www.tanzania.go.tz (accessed on 6 January, 2012).

WHO, 2004. Global burden of disease 2004 update: disability weights for diseases and conditions. Available at: http://www.who.int/healthinfo/global_burden_disease/GBD2004_DisabilityWeights.pdf (accessed on 7 January 2012).

World Resources Institute. 2011. Africa Data Sampler (ADS): digital data sets for Africa. Available from the World Resources Institute at: http://gcmd.nasa.gov/records/GCMD_ADS_WRI.html (accessed on 6 January 2012).