



The University of Pretoria Institute for Sustainable Malaria Control: Transdisciplinarity in action for a malaria-free Africa

The global malaria challenge

According to the World Health Organisation (WHO), in 2018 there were an estimated 228 million cases of malaria globally. Of those, 93% (213 million cases) occurred in the WHO Africa Region (WHO 2019 Report). For the same year, there were an estimated 405 000 malaria deaths worldwide. Children under the age of five, pregnant women, immune-deprived, and the elderly are particularly vulnerable to severe disease. In sub-Saharan Africa, a child dies from malaria every two minutes. These figures are even more disturbing when one considers that malaria is both treatable and preventable.

South Africa is among the countries in Africa that continue to battle with malaria: more than 10% of the South African population live in malaria-endemic areas. Three of South Africa's nine provinces – Limpopo, Mpumalanga, and KwaZulu-Natal – are endemic for malaria. To achieve the goal of malaria elimination, countries need to achieve zero local transmission. The challenges to zero local transmission are complex

however, and traditional narrow approaches are unlikely to make any headway. Targeting one aspect of the disease alone, such as effective treatment, is insufficient as a lone target. A holistic view of the “malaria system” and acknowledging the complexity of the challenge is needed. This is particularly relevant on the African continent, where the suite of challenges around health, poverty, and inequality (to name a few) are inherently complex. No magic bullets are available, and the best intended narrow initiatives, while solving the problem superficially, can create unintended and negative consequences in other parts of the system. For instance, incorrect use of insecticides to kill the mosquito (the vector), could result in adverse health impacts on human beings.

The interdependent relationship between malaria and the Sustainable Development Goals (SDGs) highlights this complexity, along with the broad scope of the challenge <https://www.up.ac.za/up-institute-for-sustainable-malaria-control/article/2880905/sustainable-development-goals-and-malaria>. The “malaria system” connects across the raft of SDGs, by either influencing SDG outcomes, or being influenced by them. For example, poorly managing endemic malaria will have negative impacts on poverty, food security, and other SDGs. On the other side of the same coin, unmanaged waterways and poor sanitation could increase mosquito breeding habitats and hence increase rates of malaria transmission. Malaria slows economic growth in Africa.

Institutions of higher education are compelled to respond, and it is increasingly evident that we cannot transform our world, without the research and interventions of universities. This in no way means “business as usual”, and in many ways, universities will also need to reimagine themselves

as part of the transformation. At the heart of finding new ways to understand and address complex challenges, as we see with malaria, is the need to embrace a transdisciplinary approach. An approach that crosses the boundaries of functional discipline-based knowledge i.e. bringing together the right mix of talents and mobilising the creativity and ideas needed for sustainable solutions.

While much is spoken about transdisciplinarity, turning it into reality is an inherently more difficult proposition. It needs to be designed into organisational structures and processes, not bolted on or resting in the hope that it will happen by chance. The University of Pretoria Institute for Sustainable Malaria Control provides a window into what transdisciplinarity in action looks like, and how it can be used to help transform our world.

The University of Pretoria Institute for Sustainable Malaria Control

The University of Pretoria Institute for Sustainable Malaria Control (UP ISMC) was specifically established as a transdisciplinary platform to promote collaborative research within the University on safe and sustainable malaria control and management. At the outset, the Institute consolidated the wide array of leading research in malaria underway across different faculties of the University. A vehicle was thus established that was better positioned to deal with complex challenges than preceding individual and siloed efforts. A shared focus with the intent of eliminating malaria and promoting health and making a substantial contribution towards a malaria-free Africa brought coherence to activities and a common line of sight.

The implications of consolidation were manifold: a multi-dimensional view of the complex challenge was now possible and talented and creative people from different areas of expertise could sit around the table – or subsidiary tables – to build a holistic view of the challenge. The broad nature of the challenge could be broken down into its component parts – the malaria system – connecting the dots to show how all the pieces could fit together. This connectivity, clarifying linkages and dependencies, set the scene for a strategic approach — one that would be more likely to shift change than independent activities addressing limited aspects of the system in a tactical way. The system view enabled the identification of points and pathways of influence, where addressing them would create leverage, and demonstrate the power of transdisciplinarity. Coming around the table, participants also brought along with them

access to their vast faculty networks and infrastructure.

Given the diverse scope of malaria, the Institute transcends individual faculties, and all UP faculties as well as the Gordon Institute of Business Science (GIBS) have an association with the UP ISMC. Those most intimately involved include the Faculties of Health Sciences; Natural and Agricultural Sciences; Engineering, the Built Environment, and Information Technology; Veterinary Science; and Education. Leveraging off the leading work and credibility of this transdisciplinary core, broadening the platform and involving external collaborators and funders at both national and international levels, was a natural and logical progression of the literal implementation of the Institute. As testimony to the UP ISMC's credibility and influence, the Institute hosts the SARChI Research Chair in Sustainable Malaria Control and the Community of Practice in Malaria Elimination. The South African Research Chairs Initiative (SARChI), is led by a collaboration between the Department of Science and Innovation (DSI) and the National Research Foundation (NRF). It is designed to significantly expand the scientific research base of the country. Hosting the chair validates the UP ISMC's relevance, its alignment to South Africa's national development, and its contribution to making South Africa competitive globally. The UP ISMC is also a South African Medical Research Council (MRC) collaborating centre for malaria research, once again confirming recognition at the highest national level.

The UP ISMC collaboration is not limited to partners within UP or other research or tertiary entities in South Africa and internationally. The Institute works closely with government (Directorate for malaria and other vector-borne diseases and zoonoses), provincial malaria control programmes in South Africa, and other entities such as Elimination 8 (E8). The E8 initiative is the malaria response arm of the Southern Africa Development Community (SADC).

The core concept

The Institute's core concept is deceptively simple. In the system there are three main aspects: the vector, the parasite, and the human being.

The mosquito is the vector that carries the parasite; the parasite is the agent that causes disease; the human gets the disease when infected by the parasite, and provides infected blood as food to the mosquito, for an expanding cycle of infection, unless disrupted.

Each aspect has a particular set of characteristics, and the interfaces between aspects also have defined characteristics. At each level, in order to

connect the characteristics of aspects or interfaces to choices around strategic disruption, we can explore: the characteristics of the aspect or interface; any influencing variables which might change the characteristics, such as climate change; the specialty capabilities needed for understanding (research), or action (interventions); and the range of options for strategic intervention and disruption.

By understanding and mapping details of the entire system, we can determine who needs to be part of the conversation and what each can bring to it; we can determine how we would work together with a higher order of sophistication, and choose the points of leverage to apply our energy and strengths for maximum effect.

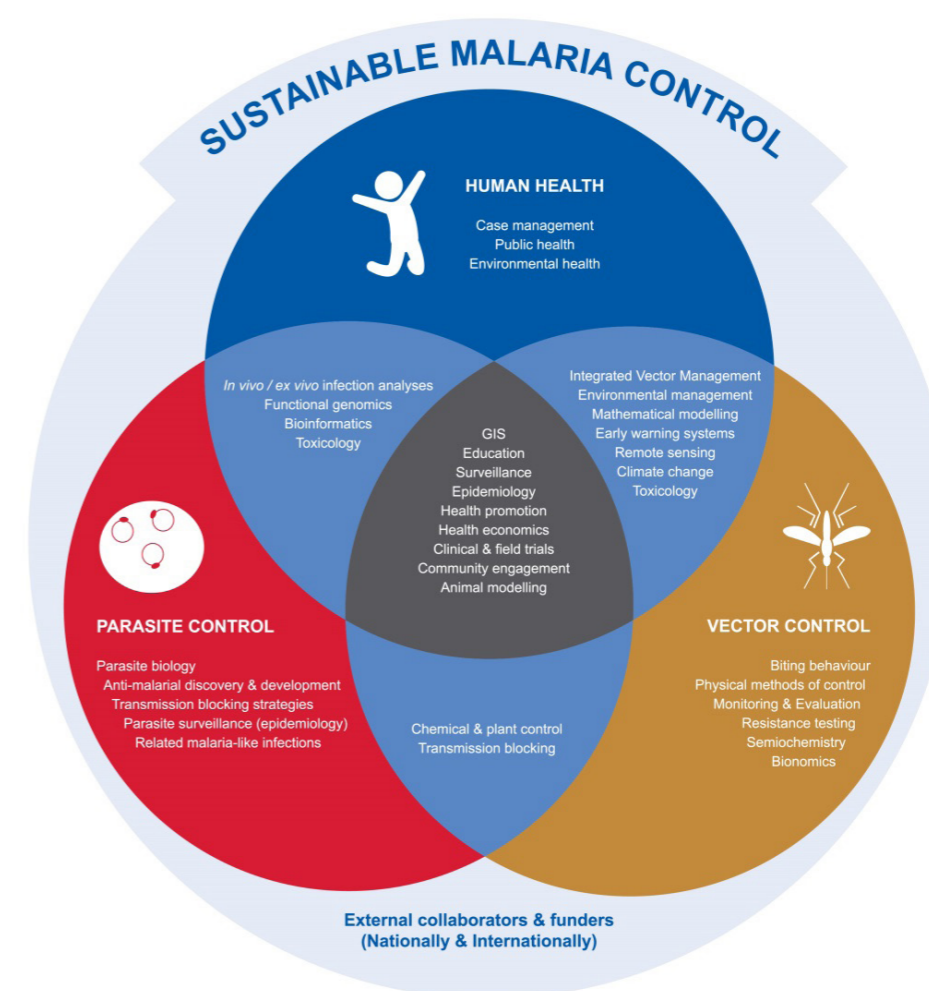


Figure 1: The UP ISMC concept

Translating the concept into practice

The Institute has a lean and uncomplicated structure to provide oversight and translate the concept into reality. An Advisory Board comprises the University's Vice Principal: Research and Postgraduate Education as Chairperson, and the Deans of three faculties. There is facility for the appointment of independent non-executive members. The Director of the Institute, supported by a Project Manager, manages the day-to-day activities which enable the Institute's effectiveness.

Research is organised into clusters flowing from the aspects of the core concept – the Human Health Cluster, Parasite Control Cluster, and Vector Control Cluster. Each cluster has a small pool of core researchers, each with access to a much wider group of internal and external collaborating researchers. The core concept provides a framework for the requisite competencies and work focus for each cluster, and across interfaces. Important competencies and areas of focus within the framework, as provided by the core concept, can be expanded in increasing circles of complexity and influence as knowledge grows. The core concept itself remains unchanged.

Human Health Cluster	Human – Parasite	Human – Vector	Human – Parasite - Vector
<ul style="list-style-type: none"> · Case management · Public health · Environmental health 	<ul style="list-style-type: none"> · In vitro / in vivo infection analysis · Functional genomics · Bioinformatics · Toxicology 	<ul style="list-style-type: none"> · Integrated vector management · Environmental management · Mathematical modelling · Early warning systems · Remote sensing · Climate change · Toxicology 	
Parasite Control Cluster	Parasite - Human	Parasite – Vector	<ul style="list-style-type: none"> · Geographic information systems · Education · Surveillance · Epidemiology · Health promotion · Health economics · Clinical & field trials · Community engagement · Animal modelling
<ul style="list-style-type: none"> · Parasite biology · Anti-malarial agents · Transmission blocking · Parasite surveillance · Related malaria-like conditions 	<ul style="list-style-type: none"> · In vitro / in vivo infection analysis · Functional genomics · Bioinformatics · Toxicology 	<ul style="list-style-type: none"> · Chemical and plant control · Transmission blocking 	
Vector Control Cluster	Vector – Human	Vector – Parasite	
<ul style="list-style-type: none"> · Biting behaviour · Physical controls · Monitoring & evaluation · Resistance testing · Semiochemistry · Bionomics · Larval control 	<ul style="list-style-type: none"> · Integrated vector management · Environmental management · Mathematical modelling · Early warning systems · Remote sensing · Climate change · Toxicology 	<ul style="list-style-type: none"> · Chemical and plant control · Transmission blocking 	

Figure 2: Mapping cluster functional / interface competencies and work areas

The combination of the core concept, enabling structure, and competence/work mapping, hardwires a transdisciplinary approach into the institute’s activities, and the way in which they get done.

Making a difference

The Institute’s results through the transdisciplinary approach, speaks for itself. Over the three-year period from 2017 – 2019, UP ISMC researchers and affiliated members published 50 articles in peer-reviewed journals, and wrote chapters in two

separate books. For the same period, nine PhD theses and 13 MSc dissertations were successfully completed. Publications, doctorates, and master’s degrees were applicable across the spectrum of the malaria system, and this fact reflects that the capability being built through the transdisciplinary approach goes beyond a specialist focus on malaria.

Capabilities can be transferred across different dimensions. Presentations at national and international conferences have been myriad <https://www.up.ac.za/up-institute-for-sustainable-malaria-control/article/2916394/conference-participation>, and it is clear that the Institute is “at the table” and playing a meaningful role in shaping the malaria dialogue.

Collaborations between the Faculties of Health Science, Education, and Humanities have given rise to innovative forms of malaria education. These include through music and visual arts, with short drama stories, plays and creative art. They have been especially useful for younger children, and one such collaboration led to the development of the informative book *Sibo Fights Malaria*.

On the ground and in partnerships with affected communities, through the Malaria Awareness Programme (MAP) led by the One Sun Health public initiative, intensive training of community health workers is undertaken in the homes of traditional leaders in several villages. To date, the MAP has trained over 80 local health workers to empower over 1,300 community members throughout the Limpopo Province. In the near future, it is anticipated that the MAP’s reach will be scaled to other high-risk regions, replicating its model to improve other key health threats in these communities.

The Institute’s researchers have developed innovative tools — from mosquito repellent formulations and protective clothing (socks and ankle bands) for outdoor vector control, to insecticide-impregnated wall linings for indoor protection — as safer and more sustainable methods to control vectors. In other innovative projects, UP ISMC researchers are going as far as considering the variation in human attractiveness to mosquitoes, and their preference to bite select regions of the human anatomy, as prospective avenues to identify compounds effective for lure-and-kill strategies.

The Remote Sensing for Malaria Control in Africa programme (ReSMaCA) is a UP ISMC initiative with a holistic approach for a better understanding of the major driving factors, and identification of hotspots for potential malaria outbreaks. The programme uses remote sensing or satellite technologies to assess environmental drivers including climate and climate change, human social and behavioural drivers including cross-border movement, vector aspects, parasite aspects, and changes thereof. The ultimate goal is to develop an integrative malaria surveillance and early warning system that would provide and guide decision-makers with evidence-based results to advise malaria control programme planning, implementation, monitoring and evaluation. Partners in this programme include

the French National Space Agency (Centre National d’Études Spatiales – CNES), the South African National Space Agency (SANSA), the South African Weather Service (SAWS), Aix-Marseille University in France, and other research and tertiary institutions. From the attention the ReSMaCA programme has attracted, it will soon be rolled out in southern Mozambique, with Goodbye Malaria as partner.

The Institute also provides services through its Malaria Parasite Molecular Laboratory (M2PL) and insectary. The M2PL’s expertise lies in systems biology approaches to discovering druggable targets as well as processes in the malaria parasite. The laboratory has the largest malaria parasite cultivation facility in South Africa. It is capable of producing all life-cycle forms of malaria parasites associated with human infections. The facility also runs a comprehensive antimalarial drug screening platform, uniquely screening for drugs able to kill at all stages of the life cycle. The insectary is not only used for vector-control research, and it will soon be open for insecticide and repellent testing of commercially developed products.

Based on its successful model, high impact, and demonstrated contribution towards a malaria-free Africa, the SARChI Research Chair in Sustainable Malaria Control was approved for another five-year cycle from 2018, and in 2020 the Community of Practice in Malaria Elimination was renewed for another two years. The SARChI Research Chair was also upgraded to Tier 1 in 2019.

Closing thoughts

In reflecting on the success of the Institute, it is clear that this is not just about malaria. Malaria as a global challenge is important, and responding to it is significant. But there is something more here, grounded in the ability to successfully translate the concept of transdisciplinarity into practice, placing critical importance on the *way of doing things*. Arguably, the central piece is the simplicity of the core concept with a somewhat modular structure. It allows configuration and enhancement of the content and the focus of activities over time, without changing its fundamental structure. This is a hallmark of a resilient system, and it is likely that the UP ISMC can represent a generic model of transdisciplinarity, where these learnings and the underlying principles of success can be adapted and applied in other contexts.