UNIVERSITY
OF BRESCIA

The PhD in

Appropriate Methodologies and Techniques for International Development Co-operation:

origin, evolution and activities

2025

SUMMARY

PRESENTATION

The **doctorate in "Appropriate Methodologies and Techniques in International Development Cooperation"** was born in January 2008 (XXII cycle) as a meeting point between the Faculties of Medicine and Engineering of the University of Brescia on the issues of cooperation with countries in limited resources. From the beginning, the Doctorate has been divided into the Technological and Health curriculum (coordinator Prof. C. Collivignarelli; contact person for the health curriculum Prof. F. Castelli).

Starting from the **XXIX** cycle, the doctorate in "Appropriate methodologies and techniques for international development cooperation" merges as a **curriculum into the departmental research doctorate in "Civil and Environmental Engineering" (DICA)** (coordinator Prof. R. Busi), maintaining the themes and the contents unchanged compared to previous cycles and maintaining the health and technology tracks.

From the **XXXI** cycle the name of the Doctorate was changed to **"Civil and Environmental Engineering, International Cooperation and Mathematics" (DICACIM)** (coordinator Prof. B. Bacchi), to enhance the component linked to the themes of international development cooperation. Since November 2017 the coordinator of the Doctorate is prof. M. Pilotti (Prof. S. Sorlini, contact person for the curriculum in Methodologies for Cooperation and technology track and Prof. A. Matteelli contact person for the health track).

The curriculum in "Appropriate methodologies and techniques in international development cooperation" is supported by the “Alberto Archetti” Fund established at the Bresciana Community Foundation.

The **aims** of the curriculum are:
• The training of young people to be assigned, as operators, to the technical cooperation sector;
• The valorization of research as a tool for the study of appropriate solutions in the health and environmental fields to be applied in developing countries.

The **topics** addressed concern:
• Technology tack: the appropriate technologies for the management of drinking water, wastewater, solid waste and energy.
• Health track: major infectious endemics (HIV, malaria, tuberculosis, parasitic endemics), maternal and child health and malnutrition.

The objective of the course is to train professional figures who can find employment in the drafting and evaluation phases of development cooperation projects, in their supervision and coordination, as well as in the on-site implementation of activities. The training proposal responds to the needs of the complex sector of international cooperation which is expanding both in our country and in the European Union and requires trained professionals to be able to optimally channel the limited resources available.

Doctoral students have the possibility of spending part of their doctorate (up to half the duration of the course) abroad for training activities and active participation in the field in cooperation projects.

EDUCATION GOALS

General Objective
The candidate will be able to correctly plan international cooperation interventions focusing on low- and middle-income countries aiming at sustainable development through the elaboration of scientific criteria that aim to strengthen research and develop innovative solutions, for the contexts examined, applicable to the solution environmental problems and medical-sanitary problems.

The specific objectives are listed below for each curriculum.

Technology track
• Analyze the technical problems in the environmental field and the solutions applicable in low-and middle-income countries.
• Define, test and implement at real scale appropriate technologies for environmental management in low-and middle-income countries.
• Transfer knowledge on appropriate technologies for environmental management low-and middle-income countries (technical-training initiatives)

Health curriculum:
• Analyze the socio-economic and technological determinants of health in specific contexts in low-and middle-income countries.
• Plan international health cooperation interventions to benefit communities in low-and middle-income countries.
• Plan research interventions aimed at sustainable development in compliance with ethical parameters.
• Plan and implement training interventions and transfer of knowledge and skills in the healthcare sector.

The **training course**, lasting 3 years, is divided into:
• Teaching activity: divided into basic teaching, common to the two curricula, and sector teaching, specifically addressed to each of them. It involves participation in seminars, specialization courses, conferences, etc;
• Research activity: experimental activity both in the laboratory and on a pilot/field scale to test the efficiency and applicability of appropriate solutions in the technical-environmental and health fields;
• Project activities: characterizing element of the doctorate. It consists of participation in international development cooperation projects and carrying out missions in developing countries during which the doctoral student can apply the knowledge acquired in the previous phases and implement the solutions studied on a real scale, together with local subjects.

The entire course is specifically dedicated to learning research and management skills that could find an operational outlet in International Cooperation activities managed at both supranational (International Organisations) and national (General Directorate for Development Cooperation, Ministry of Foreign Affairs) levels which local within the programs promoted by Non-Governmental Organizations (NGOs).

For the **technology track,** the course will be roughly divided into the following phases:
• study and knowledge of problems in the engineering-environmental field and the appropriate technologies for their solution
• experimental search for solutions applicable in the context under examination
• pilot/real-scale application of appropriate technologies in development cooperation projects in countries with limited resources

• internships at research institutes, universities, NGOs, etc. for the development of research activities and practical experiences in the implementation of field projects in collaboration with the various public and private partners involved.

In particular, for the **health track**, the Clinic of Infectious and Tropical Diseases of the University of Brescia, reference location for the teaching and research activities of the health curriculum of the Doctorate, conducts numerous specific research activities in the sector of health cooperation for development. In particular, the rich network of contacts and collaborations that allows and fuels this activity is made up of public partners (research institutes, partner universities on the ground, Ministries of Health of the states hosting the projects, etc.) and private partners, essentially to the world of volunteering (Non-Governmental Organisations). The health track includes research and training internships at these partner institutions as part of the various specific ongoing research projects.

RESEARCH THEMES

1. TECHNOLOGY TRACK

Water for human supply: the availability of water represents a necessary condition to guarantee acceptable hygienic and sanitary conditions and to allow human development. Unfortunately, in many developing countries this resource is not quantitatively sufficient, and its quality is often poor. In addition, incorrect use of water supply systems can contribute to further worsening the quality and reducing the quantity available. In addition to human use, water is an indispensable resource for the development of all activities, in particular agriculture and livestock, which are predominant in many countries with limited resources. The rational use of this resource requires the use of appropriate tools and technologies that allow it to preserve its quality from origin to final use and guarantee adequate availability to satisfy demand. Appropriate technologies fit into this theme at different levels in the following main aspects: planning of collection systems (roofs for rainwater, natural and artificial catchment basins, etc.), natural water capture, waste collection/transport systems water from the source to the end point of use, water treatment technologies to ensure its healthiness, quality monitoring, etc. Some specific aspects that fall under this theme are: the removal of specific pollutants, such as fluorides and arsenic; the use of appropriate disinfection tools; the use of appropriate water quality monitoring techniques, etc.

Wastewater: The use of primary water generates wastewater whose characteristics vary depending on the activity from which it comes. The collection and treatment of this water is necessary to avoid both pollution of natural waters and the spread of infectious diseases transmitted by agents contained especially in faecal substances. Often, in countries with limited resources, there are no adequate structures for their collection and treatment, which generates disastrous effects on the environment and health. To reduce these consequences, it is necessary that wastewater is adequately collected (with sewage networks or latrines) and treated (with septic tanks, lagoons, wetlands, UASB reactors, etc.) to obtain a purified waste that can be correctly disposed of in the soil or in the receiving bodies. Therefore, appropriate, simple and effective technologies must be studied and tested, which are capable of removing pollutants and which, at the same time, allow the valorization of nutritional resources in which wastewater is often rich. Some specific themes to be developed in this area are: the study of technologies for treating wastewater in order to allow its agricultural reuse; treatment and disposal of hospital wastewater.

Solid waste and energy: Urban solid waste management is one of the main public and environmental health problems in developing countries. Although administrations in some developing countries are increasingly aware of this problem, waste produced in ever greater quantities following population growth and the exodus to cities is an emerging problem, especially due to the lack of adequate collection procedures, recovery and elimination. Waste management is often carried out inadequately and, in particular, at local level, it is often faced with a reality in which a lack of technical

competence and financial resources are inadequate. Furthermore, in many countries, the informal sector plays a fundamental role in waste management, especially in the collection and separation phases of recoverable product fractions. Unfortunately, it often happens that these minimum services are not provided adequately; This results in waste being abandoned on roads, rivers and land, without any environmental protection system, leading to environmental degradation and considerable risks for the population. Often, in addition to the presence of a disorganized system at a local level, there is a lack of specific knowledge about the technical solutions that can be applied to solve the problem. This topic includes numerous aspects that deserve further study at the level of research and pilot/real planning in countries with limited resources: waste collection systems, technologies for treatment/elimination/recovery of waste, design criteria and management of landfills, criteria for the energy recovery of waste, technologies for the recovery of materials (plastic, paper, iron, etc.) from waste, etc.

2. HEALTH TRACK

Major infectious endemics: in countries with limited resources, infectious diseases still represent the main cause of morbidity and mortality, especially, but not only, in pediatric age. The HIV infection epidemic affects more than 40 million people, mainly on the African continent, posing very serious health problems, but also economic and social problems. Malaria infection, which is increasingly less sensitive to available medicines, is the cause of death for around 2 million people with great suffering and significantly influences the development potential of large areas, especially on the African continent. Likewise, tuberculosis infection is expanding, also increasing mortality from HIV infection. Numerous other infections with potential spread (meningitis, sexually transmitted diseases, dengue fever and yellow fever) constitute a formidable obstacle to human development and require innovative intervention measures aimed at de-unifying their impact.

Maternal and child health: maternal mortality in some developing countries can reach values equal to 1,000/100,000 pregnancies, approximately 100 times higher than the values observed in Western countries. The accessibility of pregnant women to prenatal care services is conditioned by economic, logistical and cultural factors that have not yet been clarified in detail. Maternal mortality is essentially attributable to sepsis, hemorrhage and eclampsia. Estimates from the World Health Organization indicate that the number of neonatal deaths per year is 4 million. Added to this are another 8 million deaths before the age of 5, mainly due to infectious diseases (malaria, measles, pneumonia, diarrhea, etc.). This humanitarian catastrophe requires urgent research activity that can clearly indicate the most appropriate interventions adapted to specific contexts.

Malnutrition and lack of drinking water: this aspect of health is strictly interconnected with the more specifically technological and environmental engineering activities of the Doctorate, specified below. More than 80% of the human population does not have adequate and constant access to sources of drinking water. This is an inevitable cause of intestinal infections and infestations, with clear repercussions on health in terms of mortality (especially infant mortality), but also malnutrition. The presence of intestinal helminths, in fact, exerts a destructive, often anemic, action and reduces the absorption of micronutrients. In childhood, this inevitably leads to greater susceptibility to infections and difficult psychosomatic growth, with clear social repercussions as well.

PhD STUDENTS

Technology track

Name and surname: Elisa Gregorio

Cycle: XL – 2024/2025

Course: Civil and Environmental Engineering, International co-operation, and Mathematics (DICACIM)

Curriculum: Appropriate methodologies and techniques for international development co-operation

Supervisor: Sabrina Sorlini

Title: to be defined

Name and surname: Arumadura Aruna Manoj Prasad Silva

Cycle: XL – 2024/2025

Course: Civil and Environmental Engineering, International co-operation, and Mathematics (DICACIM)

Curriculum: Appropriate methodologies and techniques for international development co-operation

Supervisor: Sabrina Sorlini

Title: to be defined

Name and surname: Mohamed Elkhider

Cycle: XXXIX – 2023/2024

Course: Civil and Environmental Engineering, International co-operation, and Mathematics (DICACIM)

Curriculum: Appropriate methodologies and techniques for international development co-operation

Supervisor: Sabrina Sorlini

Title: to be defined

Name and surname: Maria Pezzato

Cycle: XXXVIII – 2022/2023

Course: Civil and Environmental Engineering, International co-operation and Mathematics (DICACIM)

Curriculum: Appropriate methodologies and techniques for international development co-operation

Supervisor: Sabrina Sorlini

Title: Water Safety Plans for disaster preparedness

Name and surname: Dilshan Premahtilake

Cycle: XXXVII – 2021/2022

Course: Civil and Environmental Engineering, International co-operation and Mathematics (DICACIM)

Curriculum: Appropriate methodologies and techniques for international development co-operation

Supervisor: Mentore Vaccari

Title: Sustainable mining: Recovery of critical raw materials from batteries using environmentally friendly technologies

Name and surname: Mariachiara Bonetti

Cycle: XXXVI – 2020/2021

Course: Civil and Environmental Engineering, International co-operation and Mathematics (DICACIM)

Curriculum: Appropriate methodologies and techniques for international development co-operation

Supervisor: Giulio Maternini

Co-supervisor: Sabrina Sorlini, Gianni Gilioli

Title: Traditional building systems and contemporary environmental sustainability: vernacular architecture, agriculture and social inclusion

Health track

Name and surname: Gianluca Di Rosario

Cycle: XXXVI – 2020/2021

Course: Civil and Environmental Engineering, International co-operation and Mathematics (DICACIM)

Curriculum: Appropriate methodologies and techniques for international development co-operation

Supervisor: Alberto Matteelli

Title: Global Health: exploring connections among infectious diseases, social determinants and lifestyles

RESEARCH DOCTORS

Technology track

Name and surname: Wijepala Abeysinghe Mudiyanselage Asanka Nuvansiri Illankoon

Cycle: XXXV – 2019/2020

Supervisor: Sabrina Sorlini

Title: Safety, sustainability, and valorization of agricultural waste in low-income countries

Project location: Italy, Sri Lanka

Context and problem
The increasing amount of organic waste from agriculture, primarily from rice production, in Asian countries and other developing countries causes environmental problems due to unsustainable waste management systems and low awareness of the potential of these by-products. Also, many stakeholders, especially in developing countries, follow a linear economic model called the "take-make-waste" concept. This linear model leads to significant environmental burdens and the destruction of valuable resources without realizing their true value. As such, the idea of a circular economy can help to transform these wastes into valuable products.

Objectives
This work aimed to identify the possible, sustainable and most suitable valorization options to valorize agricultural by-products in the rice industry.

Activities

The research methodology was mainly focused on the valorization of rice industry by-products through the assessment of waste value chains, developing a holistic framework to identify suitable and available rice industry by-products and suggesting potential through experimental analysis. Finally, an attempt was made to identify and propose the ideal valorization option based on environmental, social, technological, and economic perspectives and develop the relevant business model to implement the identified option. Current valorization options for by-products from the rice sector were determined based on a literature review on agricultural waste valorization. Challenges and opportunities associated with its enhancements were recognised, and suitable solutions were recommended.

Results
The most common and diversified valorization option is energy generation from waste biomass. Biochar production was recognized as a viable valorization alternative for the environmentally responsible management of byproducts from the rice business. The findings demonstrated that biochar production offers a viable avenue for the valorization of waste materials from the rice industry in Sri Lanka. The research was expanded to determine the socioeconomic factors that would affect the viability of biochar production. This led to the development of a compact biochar production unit for use by stakeholders on a small scale with an interest in rice industry byproducts that is both affordable and easy to deploy. The main objective of implementing the new reactor model is to create a technology that can regulate the pyrolysis temperature and biomass residence time under field and domestic conditions. The possibility of employing biochar as an energy storage material and as an adsorbent in wastewater treatment was evaluated in light of the positive features of biochar and the present research gaps in these fields. The evaluation's conclusions provided new opportunities for turning rice waste into high-value products.

Future developments
It is recommended that future studies encompass comprehensive life cycle assessments, rigorous economic analyses, and in-depth exploration of biochar applications and production methodologies to further expand our understanding and potential in this field.

Name and surname: Teklit Gebregiorgis Ambaye

Cycle: XXXV – 2019/2020

Supervisor: Mentore Vaccari

Title: Bioremediation of soil contaminated with petroleum hydrocarbons: process evaluation through bioslurry reactor and bioelectrochemical system approaches

Project location: Italy

Context and problems

The excessive use of petroleum hydrocarbons (PHCs) leads to high pollution in water and soil environments. Crude oil spillage contamination is common during offshore oil drilling, transport, and onshore transfer in many parts of the world. PHCs in the soil can also change the physical and chemical properties of the topsoil and the subsoil. They also have phytotoxic effects on seed germination, crop growth, and yield. Therefore, to reduce the danger of exposure, restore soil function, and provide ecosystem services, remediation of contamination is required for the restoration and reclamation of affected soil for various uses, including agriculture. For this reason, bioremediation and, particularly, the use of bioslurry and microbial electrochemical treatment (MET) approaches have emerged as effective and feasible techniques with high remediation potential, especially for soils polluted with petroleum hydrocarbons, which often contain the highest pollution levels and are difficult to treat with conventional approaches.

Objectives

This work aimed to develop a sustainable approach to bioslurry and MET systems for the effective and efficient treatment of PHCs from the soil.

Activities

The biodegradation of PHCs in the soil was investigated in six bioslurry reactors using different external stimulants, such as nutrients, activated sludge, synthetic surfactants, and long-chain rhamnolipids. Comparative analysis revealed that the combination of activated sludge, nutrients, and biosurfactant resulted in a 79.4% reduction in PHCs after ten days in the mesocosm experiment compared to the control treatment. A reactor system that includes boron-doped diamond as an electro-fenton-based anode and biological processes driven by long-chain rhamnolipids was developed to treat petroleum hydrocarbon-contaminated soil. In addition, the parameters that affected the optimum conditions, such as changes in intermediate generation, pH, hydroxide concentration, and soil organic matter composition, were also studied.

Results

The study showed that the combination of systems led to a PHC degradation rate of 93.6% in 72 h, which is 40% higher than that of a single system owing to excellent synergistic effects. To enhance the degradation of PHCs and electron transfer, 10, 50, and 100 mg/L of rhamnolipid biosurfactants were added to the anolyte of MET. The results showed that rhamnolipids at a dose of 100 mg/L facilitated the degradation of PHCs (72 %) and promoted the highest bioelectricity generation (9.5 Am2) in 20 days. Furthermore, the biosurfactants induced a special microbial enrichment associated with electrochemically active bacteria like Geobacter and Desulfovibrio and oil-degrading bacteria like Pseudomonas and Acinetobacter. Using MET as a tool, this study confirmed for the first time that novel long-chain rhamnolipids produced from non-Pseudomonas bacteria could remarkably facilitate the degradation of PHCs via extracellular electron transfer, which provides novel insights into the mechanisms of rhamnolipid regulation of petroleum hydrocarbon degradation. The study showed a significant improvement in the biodegradation efficiency and electricity generation of PHCs from polluted soil with the addition of rice straw biochar. This work demonstrated that by adding an optimal dose of biochar (8% w/w), the maximum current density was 3.5 A/m-2 , and the highest PHC reduction rate was achieved at 87.8 % in 20 days. However, excessive biochar use (12% w/w) caused adverse effects, with the extracellular electron transfer efficiency diminished by 87.5% compared to the biochar dose (8%). Furthermore, microbial community analysis confirmed that biochar enrichment could form electroactive biofilms of the gram-negative sulfur-reducing bacteria Desulfuromonas. The overall findings of this study suggest that MET technology can be used to treat petroleum hydrocarbon-contaminated soil systems while also recovering energy effectively.

Name and surname: Ahmed Mohammad Nafea Masoud

Cycle: XXXV – 2019/2020

Supervisor: Sabrina Sorlini

Title: Integrating Nature-based solutions – Constructed wetlands in sustainable sanitation and water management in Mediterranean countries

Project location: Jordan, Italy

Context and problem

Water and sanitation challenges, exacerbated by population growth and urbanization, affect over 3.6 billion people globally. Despite efforts to enhance sanitation, the absence of safely managed services persists, with conventional wastewater treatment systems posing financial barriers, particularly for small communities. Low-cost and sustainable alternatives like Constructed Wetlands (CWs) as Nature-based Solutions (NBS) gain interest. However, in certain Mediterranean contexts, CWs face limitations tied to sustainability and community acceptance, necessitating further investigation. Focusing on Jordan and Italy, where 65% and 30% of rural residents lack wastewater services, respectively, the research explores decentralized solutions like CWs – NBS for sustainability. Jordan, ranked second in daily water availability, grapples with economically unfeasible conventional engineering for small communities, prompting consideration of alternatives. The economic and environmental viability of CWs – NBS positions them as promising solutions for addressing sanitation challenges in both countries.

Objectives

This research aimed to investigate and to determine the potential for integrating CWs – NBS in the water and environmental sector, and to analysis their sustainability as a wastewater treatment solution. In addition to assessing their resilience to climate change and analyzing the potential of connecting CWs – NBS with the circular economy.

Activities

The research included data analysis in its methodology from desk study, literature analysis, field data collections, site visits, disseminating questionnaires at different levels (stakeholder and community) using semi–structured interviews. The Contingent Valuation (CV) method was used as an analysis tool to utilize and monetize the co –benefits of CWs – NBS. The Multi – Criteria Analysis (MCA) was used as a tool to compare and evaluate the sustainability of CWs – NBS with alternatives in a selected case study in Jordan. Finaly to simulate the performance of CWs – NBS, a pilot project has been designed, implemented, monitored, and evaluated, the pilot scale CWs to treat greywater in a selected case study in Jordan.

Results

The research uncovers disparities between stakeholders' views and community preferences regarding Constructed Wetlands (CWs) as Nature-based Solutions (NBS). While stakeholders consider community acceptance a major challenge, communities favor CWs over alternative treatments. Using the Contingent Valuation (CV) method, the study monetizes co-benefits, revealing communities' willingness to pay for and accept CWs – NBS.

Emphasizing financial sustainability and a circular economy, the research explores potential local reuse of harvested reeds validated by communities. It highlights economic benefits of reusing low-cost, CW-treated wastewater, measuring communities' willingness to pay and identifying key factors influencing acceptance and payments.

In the Jordanian wastewater sector, the study underscores CWs – NBS sustainability, using Multi-Criteria Analysis to identify French CW as the most sustainable technology for Al Azraq town compared to conventional methods. Similar approaches confirm CWs' sustainability at a governmental facility level.

The research concludes by highlighting CWs' sustainability through pilot-scale implementation. The horizontal flow CW effectively treats greywater, achieving significant pollutant removal(90% of BOD, 90% of COD, and 98% of TSS). The treated greywater, meeting Jordanian standards, is reused for irrigation, resulting in a 70% water consumption reduction and 85% cost savings. The study underscores CWs' potential as a sustainable treatment solution through thorough evaluation and successful pilot implementation.

Name and surname: Francine Duarte Castro

Cycle: XXXIV – 2018/2019

Supervisor: Mentore Vaccari

Title: Recovery of materials from end-of-life batteries in the circular economy context: addressing fragilities and proposing solutions

Project location: Italy, Brazil

Partners: Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA); Unileste-MG; RMB S.p.A.

Context and problem

The production and use of batteries to power electronic devices and electric vehicles (EVs) has increased globally. As a consequence, the generation of waste batteries is on the rise. Batteries contain hazardous and critical raw materials. Therefore, proper management of EoL batteries is essential to avoid environmental and health hazards, and supply disruption. However, after-use portable batteries are very difficult to track. Their collection depends on several stakeholders and on the existence of a well-managed reverse logistics (RL) system. When EoL automotive lithium-ion batteries (LIBs) are concerned, several management strategies may be adopted, such as repurposing, remanufacturing, and recycling.

Objectives

This work aimed at identifying specific obstacles that hinder material recovery from EoL batteries. The ultimate goals of this research are: to improve the environmental performance of batteries; to increase the circularity of materials in their life cycle; to avoid supply disruption; and to reduce waste.

Activities

Brazilian case studies were selected, in order to address the managerial issues of portable and automotive batteries. The current state of the reverse logistics (RL) chain for waste batteries in Vale do Aço, Brazil, was diagnosed. Challenges and potentialities related to its improvement were identified, and an action plan was proposed. The potential market of automotive LIBs in Brazil by 2030 was estimated and the effect of different management strategies on the flows of materials was assessed. Finally, the hydrometallurgical processing of EoL automotive LIBs was investigated, in attempt to optimize it and reduce its impacts. Statistical design of experiments (DoE) was employed to model the effect of process variables on metal yields.

Results

The results that emerged from the case studies revealed the importance of promoting awareness, stakeholder engagement, and law enforcement in Brazil. The creation of sectoral agreements that address specifically LIBs is recommended. The promotion of battery remanufacturing has the potential of reducing the intake of primary raw materials for new electrodes in 2030 in up to 6300 tonnes in Brazil, contributing to increase the circularity of materials. The experimental results showed that effective leaching of lithium from LIBs anodes can be achieved when H_3PO_4 is used as the leaching agent (YLi=89%). The developed recycling process contributes to reducing impacts of terrestrial, freshwater, and marine ecotoxicity, human non-carcinogenic toxicity, and mineral resource scarcity, being also profitable.

Future developments

Future studies should include:

1. larger sample size, in order to increase the accuracy of the logistic regression model developed for the Brazilian case study of portable batteries. Statistical sampling methods should be adopted whenever possible. In addition, awareness raising and training initiatives should be enlarged and their effectiveness should be monitored. Meetings with local stakeholders are required, in order to implement the proposed action plan. 2. the extension of the simulations conducted for the second Brazilian case study to other types of EVs and their integration to a life cycle assessment. 3. morphological analysis of products and electrode powders and investigations of leaching kinetics and mechanism. Model validation should also be performed, by including additional experimental runs out of the experimental region in study here. 4. measurements of direct gaseous emissions during recycling, including also standard mineral acids (e.g., HCl, H_2SO_4, HNO_3), for comparison. The scaled-up process proposed in the thesis should be implemented and further studied, in order to increase accuracy of the feasibility study.

Name and Surname: Carmencita Tonelini Pereira

Cycle: XXXIII – 2017/2018

Supervisor: Sabrina Sorlini

Title: WASH in schools of Anápolis (Brazil): evaluation of the management drinking water, sanitation and hygiene and implementation of good practices for risk mitigation

Project location: Anápolis (GO), Brazil

Partners: Instituto 4 Elementos, Fondazione Sipec, Statal University of Goiás (UEG), Studio “Arquitetura Viva”

Context and problem

In Brazil, the Ministry of Education census (MEC/INEP, 2017) showed that 96% of schools have water supply, but the public supply network reaches only 72% of schools. While in Anápolis, the research showed that 100% of schools have basic drinking water service, and in 2021, 92% of schools reached the advanced level offering safe water free from microbiological contamination. The securing the microbial safety of drinking water supplies is based on the use of multiple barriers, including source water protection and appropriate treatment processes, as well as protection during storage and distribution. The JMP suggests that in 2016, 335 million girls went to school without access to water and soap for washing their hands, bodies and clothes. In addition, over 620 million girls and boys worldwide lacked a basic sanitation service at their school (UNICEF/WHO, 2018).

Objectives

The aim of this research was to evaluate the level of WASH services in 12 public schools of Anápolis (Brazil) comparing with the global level to improve the management of these services.

Activities

The methodology was divided into 3 stages: working group, research and action. The working group was multidisciplinary and formed by 22 Brazilian students and 2 Italian master's students. For data collection, the following were used: analysis of school documents, photographs, observation in loco, questionnaires, interviews. The actions were divided into three phases: 1) evaluation of WASH services, microbiological analysis of drinking water before, during and after implementing the actions; 2) implementation of good WASH management practices; 3) creation of comics book and the “WASH Friendly School” guideline and environmental education.

Results

In Anápolis, all schools had an improved drinking water source, located on premises of schools, accessible to all when needed and available in insufficient quantities on the schoolyard. The average students by drinking water points ratio was 81:1. Between 2018 to 2020, the proportion of schools using safely managed drinking water increased from 42% to 92%. This indicator define the advanced and safely managed drinking water service, where the indicator for microbiological quality is E. coli. This increase was due to good practices implemented in hardware management such as replacing damaged water tanks and cleaning them and replacing drinking fountain filters every 6 months. All schools evaluated had toilet facilities separate by gender and not shared with teachers. The number of toilets for students was insufficient in 100% of schools. In the twelve schools, there was a total of 76 toilets and 4394 students being 2098 girls and 2296 boys. The ratio between the number of girls and boys and the number of bathrooms was 53:1 and 62:1, respectively. In 2018, soap was not available in 100% of the schools, which represents an important risk of diarrheal disease contamination. These schools were classified as limited service because they provide water, but there is no soap available for hand washing.

Future developments

Implementation of the project in 36 schools, creation of an APP to monitor drinking water fountains, creation of WASH clubs in schools.

Name and surname: Giovanni Vinti

Cycle: XXXIII – 2017/2018

Supervisor: Mentore Vaccari

Tilte: Municipal Solid Waste Management and Health Risks: is it time for a Solid Waste Safety Plan? Analysis of case studies from Serbia and Ghana

Project location: Ghana & Serbia

Partners: CISS (Cooperazione Internazionale Sud Sud), Università di Novi Sad (Serbia), Sandec/EAWAG (Svizzera), Emory University (USA)

Context and problem

Solid waste management SWM) represents a crucial topic that, if not adequately managed, can cause environmental and human health risks. Mainly in Low-and Middle-Income Countries (LMICs), a lot of solid waste is improperly collected and disposed of in dumpsites (or uncontrolled landfills). Such inappropriate SWM practices are frequent in Ghana and Serbia, case studies of the research. Consequently, the issue of the spread of contaminants associated with different waste management practices, transport routes and the risks they can cause in human receptors is very topical, as also emerged from recent epidemiological studies. The risks could be significantly reduced through a Solid Waste Safety Plan, conceptually similar to those existing in drinking water and wastewater/sludge and promoted by the World Health Organization (Water Safety Plan and Sanitation Safety Planning, respectively). Such a safety plan in the waste sector did not exist until this PhD thesis was written.

Objectives

The main objective of the research consisted in developing the first version of the Municipal Solid Waste Safety Plan (MSWSP). Consequently, two specific objectives were identified:

1. To conduct a systematic review of the recent scientific literature related to MSW management practices and adverse health outcomes.
1. To define the structure of an MSWSP and identify some case studies from Developing Countries to implement it.

Activities

A systematic review of the most recent scientific literature (between 2006 and 2020) dealing with the link between waste and health was conducted. A field mission was carried out in Ghana (between November and December 2019). The pandemic (Covid-19) outbreak prevented the carrying out of subsequent missions initially planned for 2020. Further information was therefore collected remotely, for the case study in Ghana, through the staff of the project partner NGO (the CISS), and in Serbia, through Prof. Batinic of the University of Novi Sad (Serbia). In Serbia, the municipal landfill in the urban centre of Novi Sad was analysed. It has much in common with dumpsites, causing significant health risks for inhabitants and workers. In Ghana, nine rural villages in the north of the country were identified, the subject of the 2019 mission, in which a series of waste management practices and the consequent health risks were analysed. Subsequently, the first version of MSWSP was created by applying it to the case studies under examination. During the research activities, we also had the opportunity to collaborate with researchers from Sandec/EAWAG (Switzerland), Emory University (USA) and the World Health Organization (Switzerland).

Results

The systematic review was also published in the open-access mode in a scientific journal (it is available here: https://doi.org/10.3390/ijerph18084331). Some residents' health risks associated with landfills, incinerators and dumpsites have been identified, although further studies will be needed. As far as the MSWSP is concerned, health risk matrices were created and applied to the case studies, the control measures aimed at mitigating the major risks were identified (based on the concept of appropriate environmental technologies), and a general analysis of the costs necessary to implement the planned interventions.

Future developments

The research involved two very different case studies in Serbia and Ghana. It will be necessary to refine the conceived MSWSP and test the methodology proposed in other case studies in developing and industrialized countries. Furthermore, new, more detailed and up-to-date epidemiological studies would be needed in the future.

Name Surname: Francesca Villa

Cycle: XXXII – 2016/2017

Tutor: Mentore Vaccari

Title: Open-Source GIS tools for local administrations: pursuing the economic sustainability of Solid Waste Management in low-income countries

Project location: Libano

Partners: Politecnico di Milano, INTERSOS

Context and problem

In low- and lower-middle-income countries, waste collection and transfer is generally managed by municipalities or local authorities, on whose budgets it weighs heavily. In comparison with high-income or upper-middle-income countries, the stages of treatment and proper disposal in protected landfills are often neglected, and the greatest effort is focused on removing waste from urban centers.

Collection and transfer costs include the cost of fuel and personnel, administrative costs, maintenance, and investment costs when vehicles or equipment in general need to be repaired or replaced. Optimization of the collection and transfer phases, as discussed by several authors in the literature, can have a positive impact on cost reduction.

Objectives

The objective of the research is to develop a strategy that allows a preliminary approach to the study of the context through readily available data and spatial analysis on geographical data, at a level that supports (but does not replace) subsequent studies on the local context. The main research tool is GIS (Geographical Information Systems), whose application to waste management ranges from modelling waste production to optimizing collection routes. The ultimate goal is the creation of a procedure that quickly identifies margins for optimizing the system to free up economic and labor resources to invest in other aspects of management.

Activities

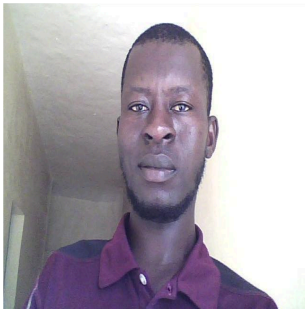
The research activity has an application aspect within a cooperation project carried out by the Politecnico di Milano and INTERSOS in Lebanon. The project involves nine municipalities, including the city of Tyre (Sour), and covers three areas: the introduction of differentiated waste collection, the preparation of waste management plans, and the optimization of a mechanical biological treatment plant located in Ain Baal. The first mission was carried out in July 2018, during 2019 I spent four months in Lebanon, divided into three missions, in 2020 three missions are planned before the project closes in August 2020. The fieldwork consisted of periodic visits to the nine municipalities involved in the project, for the preparation of management plans, through data collection and the introduction of internal tools such as the logbook for tracking consumption, and of inspections and analyses at the Ain Baal plant

Results

During the research, a number of tools were developed within QGIS, a FOSS (free open-source GIS software). These tools, which are still in the refinement phase, allow problems such as the location of collection points and their sizing, or the optimization of routes as a function of the collection vehicle and the slope, to be solved quickly through the implementation of the COPERT model for the calculation of fuel consumption.

Future developments

The use of the tools developed could support both local administrations and planners in the organization of waste management, reducing the time normally spent on these activities. The model used for calculating fuel consumption could be modified to also consider road emissions.



Name and Surname: Dame Bop

Cycle: XXXII – 2016/2017

Supervisor: Sabrina Sorlini

Title: Wastewater management, treatment and reuse in Dakar, Senegal; Study of phytoepuration in the Technopole area of Pikine

Project location: Senegal

Partner: ONAS

Context and problem

Senegal is a sub-Saharan African country that faces great difficulties in managing its environment, especially wastewater. In 2015, Senegal fell short of the 77% target set by the Millennium Development Goals (MDGs) to improve health coverage, which was 37% nationwide. Individual sanitation is more practiced in the Senegalese capital. The Technopole is a wetland located in the Senegalese capital, it is our study area, it offers a representative situation of the sanitation situation in Dakar. In the Technopole area, there is a sewage treatment plant, a lake, it is also a very conducive area for gardening, fishing, micro-gardening and other market activities. But the area's environment is in a very critical situation due to the problem of solid and liquid waste management. The farmers in the area use the treated wastewater from the treatment plant which does not meet any standards; artisanal fishermen are finding it increasingly difficult to find the fish to sin.

Objectives

The study examines the main aspects to be taken into account so that the health authorities can improve the management of wastewater in Dakar and in particular in the wetlands of the Technopole of Pikine, to test the constructed wetlands as an appropriate technology to improve the treated wastewater in the same location, to protect the Technopole area which is very rich in biodiversity.

Activities

Our activities were carried out in two main missions. The first mission was conducted in September, October, November 2017; it consisted of assessing the state of pollution of the lake, groundwater and wastewater treated by the treatment plant. This mission made it possible to determine the general pollution situation in the Technopole area, to determine the most critical areas and to know the sources of the pollution. The second mission was to test the appropriate technology to improve wastewater treated by the wastewater treatment plant receiving wastewater exceeding its treatment capacity. This study also made it possible to evaluate the general state of wastewater management in Dakar.

Results

The present study revealed that the surrounding area of the treatment plant is the most polluted area of the Technopole; the treatment plant is undersized compared to the amount of wastewater received. The analyzes conducted on the waters of the lake have also made it possible to distinguish heavily polluted areas from less polluted ones. He justified the degradation of biodiversity and the scarcity of fisheries resources. Phytopurification has been successfully tested as an appropriate technology for sustainable wastewater management in Dakar. This technology has proven to be appropriate because it requires no energy input or chemical reagents.

Future developments

The growing anthropogenic pressure due to the increase in population and the lack of means for a sustainable sanitation policy make it necessary in Dakar to implement measures to protect the environment, the quality of surface water, groundwater, treated wastewater intended for market gardening and environmental release. Household appropriate technologies can be useful and an alternative to combat hann bay pollution, household wastewater management and improve the reuse of treated wastewater.

Name and surname: Silvia Gibellini

Cycle: XXXI – 2015/2016

Supervisor: Mentore Vaccari

Title: Challenges of solid waste recycling system in Jordan: a focus on plastic and paper waste recovery in Irbid

Project location: Irbid (Giordania)

Partner: ICU

Context and problems

Jordan, classified as an upper-middle income country, with a consumerist lifestyle and high levels of urbanisation, has the urgency of an improved municipal solid waste management (MSWM) service and recycling needs to be included in it. In fact, MSWM in Jordan is still mainly organized as a linear system, including collection of unsorted waste and disposal in landfills. In recent years, the big flow of Syrian refugees, especially in the north of the country, caused a strong pressure on such system. In such context, the informal sector (mainly) is doing some activities of collection, sorting and selling valuable materials, but the system in place is not systematic and it is strongly affected by oil and energy price fluctuations. Big donors recently supported the drafting of a national strategy and of regional master plans for MSWM, but the situation does not seem to be changing. Non-governmental Organizations (NGOs) and relief organizations are supporting MSWM activities through pilot projects, but this needs to be sustainable beyond the project funding.

Objectives

This research focused on the city of Irbid, in the north of Jordan, where a development cooperation project planned to build a recycling pilot plant for plastic and paper waste, for the production of plastic pellets and of a cellulose based insulation material. The specific aim is evaluating the appropriateness of the pilot plant, according to techno-environmental, economic and social-institutional dimensions. The more general aim is identifying what has so far inhibited the development of an effective recycling system in Jordan and what are the recommendations to overcome these barriers.

Activities

Experimental research was carried out in order to determine the composition of the MSW in Irbid. In addition, comprehensive semi-structured interviews with different stakeholders (divided in four categories: institutional actors, private sector, civil society and international actors), as well as field visits to validate and complement information obtained from interviews were carried out.

In order to process the collected data and to formulate proposals for change in a systematic and shared way, the Theory of Change method was applied. The evaluation of the appropriateness of the technology applied for the pilot plant in Irbid was carried out adapting existing methods and creating ad hoc indicators in order to access the most important impacts related to the specificity of the case study.

Results

The research allowed the identification of five main categories of barriers to the development of an improved MSWM and recycling system in Jordan: lack of financial feasibility, lack of coordination, problems in the waste value chain, lack of awareness and lack of an appropriate regulatory and control system. The processing of these problems gave rise to a set of specific proposals (built as a tree diagram of actions), divided in the same abovementioned problem categories. The evaluation of the appropriateness of the technology that was chosen in the Irbid pilot plant was positive, albeit with some risks (related for example to the possible interference of/with the informal sector).

Future developments

Use of the results of the Theory of Change for planning activities by the NGO involved in testing the method, also with a view of sharing the emerged needs with the donors of the sector.

Monitoring of the pilot plant during the operational phase and analysis according to the determined dimensions, in order to identify strengths and weaknesses to better understand how the system can be scaled up.

Name Surname: Antonella Vidoni

Cycle: XXIX – 2013/2014

Tutor: Sabrina Sorlini

Title: Water supply in rural areas in Burkina Faso: the case study of the municipality of Dori

Project location: Burkina Faso

Partner: Municipality of Dori

Context and problems

As part of the WHO's activities on water and health, the 'Guidelines for Drinking Water Quality' (Worl Health Organization-WHO) are published at regular intervals and represent a fundamental tool and both an operational and scientific basis for those dealing with water, health, and water management. In arid and semi-arid regions of sub-Saharan Africa, such as those of Burkina Faso, groundwater is the main source of drinking water supply, but little information is available on water quality. Often the same source of water is used promiscuously by rural populations, whether for drinking/domestic use, livestock, or irrigation.

Objectives

The study investigates the main aspects that need to be taken into consideration so that local authorities can improve water resource management in the rural areas of the Dori Municipality in Burkina Faso. It aims to contribute to the classification and chemical-physical characterization of the main water supply points, to the search for possible causes of contamination that emerged during the study, and to the identification of operational measures and interventions for each water supply source, considering the One Health approach, which considers human health as closely linked to animal health and environmental conditions.

Activities

To collect the necessary data and information for this study, field missions were carried out in the municipality of Dori in 2014, while in 2016 the mission was limited to a stay in the capital due to security. Information and insights for further study were collected directly in the field during meetings and interviews with people, such as service managers, people in the villages, and political representatives.

Results

This study has highlighted the complexity of water resource management in the rural context of the Dori Municipality in Burkina Faso and how different issues are interconnected. When planning water resource management in rural areas, the local authorities of the Dori Municipality will have to consider the following aspects: demographic, economic, environmental, governance, management, technical, health, socio-cultural, political. One aspect on which there are no reliable studies and data is that of water supply and the opportunities to create new jobs in rural areas. A study of 10 countries, including Burkina Faso, revealed a shortage of skilled professionals in water supply and sanitation, as well as a lack of skills. The large number of projects, institutions, NGOs, and international agencies that intervene without the involvement and coordination of local authorities leads to fragmentation and dispersion of financial resources. Instead, both financial resources and knowledge should be exploited and capitalized on locally as well, with the involvement of local authorities.

Future developments

As a result of increasing anthropogenic pressure due to population growth and mining activities, it will be necessary to implement measures to protect freshwater reserves in Burkina Faso. There is a lack of quantitative and qualitative data on water resources. At the level of the Dori Municipality and the Sahel Region, it will be important to start planning not only monitoring but also the creation of simple archiving systems for technical and analytical data.

Name Surname: Fabiola Zambetti

Cycle: XXIX – 2013/2014

Tutor: Mentore Vaccari

Title: Appropriate technologies for e-waste management in developing countries: steps towards the integration of recycling and reuse

Project Location: Ghana and Palestine

Partner: University of Brescia

Context and problems
The research activity focused on the topic of electrical and electronic waste (WEEE or e-waste) in developing countries and set itself the objective of analyzing the environmental, social and economic impacts of different treatment methods (recycle and reuse) of e-waste, in order to compare possible management scenarios and to support decision-making processes in the studied contexts.

Objectives
Two case studies in 2 distinct areas are analyzed: Palestine and Ghana, which have in common a substantial informal processing of various types of e-waste, a small part of which is produced internally and most of which is imported from abroad. The functional unit analyzed is a single workshop, where an average of 5-6 workers works and where a mix of e-waste is processed, varying from day to day, depending on what is offered daily by the market. The subject of the analysis was the current situation (baseline scenario) and possible improvement scenarios that consider the use of technologies to reduce uncontrolled combustion activities. The last scenario analyzed is the one that envisages incentives for the reuse of WEEE that can be repaired and resold on the second-hand market, thus allowing access to technological products, such as computers and mobile phones, even to low-income segments of the population.

Activities
The data collection, based on observation and semi-structured interviews, consisted of analyses of available literature and field missions conducted between 2015 and 2016, and data processing employed two methodologies: mass flow analysis (MFA) and the E-Waste Integrated Assessment Scheme (EWIAS).

Results
The minimal environmental and social sustainability of the current informal processing methods in both situations is evident. The ameliorative scenarios allow for a reduction in social and environmental impacts, but at the same time led to a reduction in profits for the workshop operators, as the use of more complex technologies, increased wages, and the proper disposal of waste materials entail additional costs that significantly increase the initial investment costs and make the annual budget negative. Scenarios in which informal processing activities are combined with reuse and repair of a small part of the e-waste result in improved environmental and social impacts and in parallel improve the economic balance, which remains negative in the Palestinian case study, but is positive in the Ghanaian case study. This highlights the importance of an integration between the recycling and material recovery system and the sorting and repair system of equipment that is still usable and can be placed on the used equipment market.

Future developments
It is considered important to involve not only the stakeholders directly concerned in the activities, but also institutional and political representatives, who can influence the definition of legislation and guidelines at national and international level.

Name Surname: Lavinia Di Francesco

Cycle: XXIX – 2013/2014

Tutor: Sabrina Sorlini

Title: Study and implementation of an appropriate technology for the purification of wastewater generated by artisanal gold mining activities in Colombia

Project location: Mina Nueva and Carrisal region Antioquia (Colombia)

Partners: ACVC, UNIPAZ (Colombia)

Context and problems
Colombia is the third largest country in the world in terms of mercury emissions and the country with the highest rate of mercury pollution per capita. In particular, the Department of Antioquia, the region that includes the communities of Remedios, Segovia, Zaragoza, El Bagre and Nechí is one of the most mercury-contaminated areas in the world. Currently, the main source of mercury pollution is artisanal gold mining (ASGM), where it is used to form an amalgam from which to extract the precious metal. According to the provisions of the Minamata Convention drafted in 2013, the production, import and export of certain mercury-containing products will be banned from 2020, and the adhering countries, 128 to date, will have to draw up national plans within three

years of the treaty's entry into force that will lead to the reduction, if not elimination, of the amount of mercury used in artisanal mining.

Objectives
Identification and testing of a possible appropriate technology to improve the process of gold production in artisanal mines in and around the Cimitarra River Valley Peasant Reserve Zone, in the north-east of the Department of Antioquia and the south of the Department of Bolìvar, Colombia. The research mainly focused on the characterization and purification of wastewater from the processing of gold rock with mercury.

Activities
The research consisted of three phases: **Phase I:** Identification of treatment techniques for the removal of mercury from the wastewater of the artisanal gold mine.
Phase II: Experimentation and validation of selected treatments.
Phase III: Analysis of the appropriateness of the identified technology.

Results
The results confirmed that Aluminum Sulphate had the best mercury removal capacity of 88.29%, bringing the mercury concentration at the pilot plant outlet to 13 µg/l. The plant species considered most suitable for mercury removal is Eichhornia Crassipes, which combined a remarkable capacity to accumulate mercury in the tissues (48.55% of the total) with a high degree of heavy metal in the sedimented solids (48.50%) while minimizing the volatilized and transpired component. Although there is a good mercury removal efficiency, the discharge limit required by Colombian regulations of 2 µg/l is not reached. The implemented technology generally improves the quality of the current effluent produced by the mine. The environmental degradation to which the mining area is subjected is very high, the area under consideration can be classified as being of low environmental quality, there are problems related to the water, atmospheric and soil components, which do not depend solely on mining but also on the practices of the communities that inhabit these areas.

Future developments
The entire community has shown an important willingness to implement measures to reduce mercury contamination, the technological proposal devised is consciously considered a non-definitive technology even by the miners, but its installation could be the starting point to begin discussions on environmental quality, prevention, and protection of risks to human health and the environment.
There are still some aspects to be investigated:

- removal of residual sludge/sediment produced by chemical precipitation treatment, still containing mercury and gold.
- appropriate treatment for the disposal of the plants used for Phyto-purification, which are still rich in mercury.

Name and surname: Marta Domini

Cycle: XXIX – 2013/2014

Supervisor: Sabrina Sorlini

Title: Planning approaches for the design of improved sanitation systems in low and middle income peri-urban contexts. The case study of Iringa, Tanzania

Project location: Iringa, Tanzania

Partner: ACRA

Context and problems
The lack of hygiene and access to basic sanitation are among the biggest problems in many emerging countries. In low-and middle-income countries (LMIC), sanitation is usually based on on-site technologies, and the collection, treatment and disposal of wastewater and faecal sludge are often inefficient or inadequate. Moreover, the rapid urbanization that occurs in many peri-urban areas contributes to worsen the problem of access to infrastructure and services. The lack of adequate planning and design to guide interventions often adds to scarce economic resources, and the application of methodologies for the design of sanitation systems is still challenging, especially as regards their implementation in the field. In the suburban neighborhoods of the city of Iringa, Tanzania, almost half of the latrines were not improved. Emptying and transport of faecal sludge, as well as treatment and disposal, are not adequate and pose risks for the health of workers and communities.

Objectives
The research is driven by the following research question: How to design an improved sanitation system for peri-urban areas in low-income countries? The research aims at supporting designers working in low and middle income countries in the design of appropriate sanitation systems for peri- urban areas, taking into consideration the entire supply chain and needs and priorities of all stakeholders, with the final objective to safeguard public health and the environment.

Activities
We revised and analyzed current methodologies and tools for the design of sanitary systems in developing countries. We established criteria to select design methodologies to be tested in the case study in Iringa. The Community-Led Urban Environmental Sanitation (CLUES) and the Sanitation Safety Planning (SSP) were chosen and applied for the selection of technical options and the design of an improved system. The Sanitation Marketing (SM) and the Human Centered Design (HCD) methodologies were adopted to support the development of sanitation products and sanitation. We analyzed and discussed the results of applying each approach to the Iringa case study, highlighting strengths and limitations of their practical utilization. Finally, common or complementary elements of each approach were highlighted and combined to propose an integrated methodology that enhances the effectiveness of each individual methodology in LMIC peri-urban contexts.

Results
Studied approaches proved to be useful methodologies for planning and implementing an improved sanitation system, even if none of the tested approaches met, on its own, planning criteria and objectives set for the case study. CLUES has proved useful in addressing social and institutional issues, and technological choices in a participatory way, while the SSP has directed actions towards the protection of human health and the correct recovery and reuse of resources, requiring a deeper study and knowledge of technical solutions. The HDC and the SM allowed to take on detailed technical issues for the design and construction of latrines, as well as the economic and market issues, supporting the CLUES in creating a demand for sanitation services and products. It emerged how the combined use of these approaches strengthened their strengths and compensated for their limits, supporting the project in the creation of sustainable solutions. A methodology was therefore developed and proposed, which foresees the integrated use of the approaches analyzed for the design of improved sanitation systems in the peri-urban areas of LMIC.

Future developments
The research focused on the case study of the peri-urban areas of Iringa. It would be necessary to test the proposed methodology in other case studies with similar characteristics.

Name Surname: Federico de Nardo

Cycle: XXVIII – 2012/2013

Tutor: Mentore Vaccari

Title: Strategies to improve Organic Waste recovery in Palestine using participatory approaches and value chain analysis

Project location: Tulkarem (Palestine)

Partner: Cesvi

Context and problems
The state of Palestine is a territory that is identified in the West Bank and since 1993, when the Oslo Accords were signed is fractious and divided into several areas where only 18% is controlled by the Palestinian Authority. The rest is run by the state of Israel, which controls its borders and major communication routes, leaving the Palestinian territory in a condition of being unable to manage trade and economic relations and in complete backwardness. The population finds itself without adequate services reflected in precarious land management. Within this political framework, the waste management service is inadequate and limited.

Objectives
To provide a case study for a methodological model to be applied to commercial and industrial waste segregated management projects in resource-limited countries. The collection system was tested and applied to commercial establishments through several pilot phases with a participatory process. A second aim was to search for the best enriched compost mixtures to make the best use of differentially collected material.

Activities
A system for the separate collection of cardboard and organic waste from commercial establishments and agro-industrial activities was implemented. Participation was conducted by taking a cue from the Integrated Sustainable Waste Management (ISWM) methodology. The system devised was applied in Tulkarem (Palestine) within a pilot project funded by the Italian government and managed by the NGO Cesvi. The project was divided into 3 phases: **1)** Data collection using Waste aware indicators and selecting the reference ones for specific separate collections. **2)** Implementation of the collection system. The model tested in Tulkarem involved dividing the city into 5 areas characterized by different urban fabric, type of land use, and presence of specific activities. For each urban type, a micro-area was selected in which a pilot activation was implemented. **3)** Implementation of tests of enrichment of compost produced from the collected organic material. Separately collected organic material is transported to a composting station in the vicinity of Tulkarem city. The station was already active and is operated by the Thinnabeh Farmers' Cooperative. During the activation of the collection system, 9 compost samples were produced using the differentially collected material in the pilot stages and 3 different types of enrichment in different dosages were activated. The type of enrichment was decided in a participatory way:

- enrichment with NPK mineral fertilizer (13:13);
- enrichment with EM 01 (Effective Microorganisms) in standard solution produced by the Japanese EMRO Company (https://www.emrojapan.com);
- enrichment with single Effective Micro-organism (Bacillus Megaterium).

Results
The results of the trial of the start-up of the multi-stage pilot collection system showed that the tool based on repeated validation of the pilot stages led to progressive changes in the collection system that made it shared therefore accepted and thus sustainable and appropriate. Composts produced with EM confirmed better and faster maturation resulting in reduced time for composting, decreasing the cost and space needed for compost production.

Future developments
The separate collection system has shown the potential of separate collections. The Tulkarem municipality has expressed interest in applying the system to other materials, such as plastic and metal. The best enriched compost mixture identified will be produced by the composting plant at an industrial level, after a marketing process and demonstrations at farmers to show the advantages in using enriched compost. EM01s were purchased locally, trials will be done to reproduce the microorganisms without the need to purchase them bringing production and reduce costs and to total independence of materials.

Name Surname: Andrea Perteghella

Cycle: XXVII – 2011/2012

Tutor: Mentore Vaccari

Title: An Integrated Assessment Scheme supporting decision making in waste management in low and middle-income countries

Project location: Mozambico, Bosnia-Erzegovina

Partners: Celim (Milan), ADL Zavidovici (Brescia)

Context and problems
Waste management in resource-limited countries is a rather complex issue and is often addressed with little attention by all actors involved in a specific context, from public administrations to individual citizens. Waste management has always received secondary attention compared to access to clean water sources, health care and access to food, as also emphasized by the Millennium Development Goals (MDGs). However, waste and its poor management have a strong impact on the environment and human health, as it is a major source of chemical, organic and microbiological contaminants. The uncontrolled dumping of waste, rather than its disposal by uncontrolled burning, are the main forms of waste management practiced daily in resource-limited countries, resulting in heavy pollution of air, water, and soil, which invariably drastically reduce people's quality of life and well-being.

Objectives
The main objective of this research was to develop a decision support tool to guide sustainable waste management in resource-limited contexts. Specifically, the aim was to create a multidimensional tool (economic, environmental, and social dimensions) to comprehensively evaluate different waste management schemes according to the pillars of the sustainability concept.

Activities
During the PhD activity, several missions were carried out to Mozambique and Bosnia Herzegovina to analyze the local contexts. Data and information (social, economic, environmental aspects) were collected, mainly concerning waste management, and meetings were held with the main stakeholders involved. Through literature research, the decision-making tool was defined and subsequently tested on site.

Results
The Multidimensional Decision Support Tool (IAS):

- allows an evaluation to be carried out without being bound by the need for large quantities of specific, high-quality data, as is often the case with many decision-making tools used to obtain precise future directions. Decision-making tool (IAS)
- allows the 3 main dimensions of sustainability (economic, social, and environmental) to be analyzed, as the literature currently shows that in most cases decision-making tools are applied for a single dimension.
- the results of the decision-making instrument (IAS) are easily understood by all people, even those who do not have a deep knowledge of waste management issues and all related elements.
- the application of the IAS to case studies in Bosnia and Herzegovina and Mozambique showed an excellent adaptability to both contexts, which basically have very different characteristics, thus underlining the possibility of implementing this tool in other contexts.

The substantial differences between the two case studies analyzed (different waste management practices, different technical skills, different knowledge, and sensitivity to the problems caused by waste, different lifestyles, habits and traditions, and different economic resources), consequently imply a site-specific analysis, which in fact does not allow for a comparison between different contexts even though potentially the same technical solutions to improve waste management were applied

Future developments
Use the tool in other contexts under development, and test its reliability, in order to be able to refine it, and thus make it ductile and usable on a large scale, in order to ensure environmental sustainability with regard to waste management.

Name Surname: Andrea Pollmann Gomez

Cycle: XXVII – 2011/2012

Tutor: Sabrina Sorlini

Title: Water indicators for criticality analysis in water sanitation. The case study of Vilankulos (Mozambique)

Project location: Mozambique

Partners: Acque del Chiampo (Arzignano –VI), Municipalità di Vilankulos

Context and problems
Mozambique, located in South Saharan Africa, is one of the poorest nations in the world, as evidenced by its development index of 0.393, which places it 178th out of 187. In particular, water and sanitation are one of the country's most critical sectors, with 51% of the population lacking access to an improved water source and almost 80% lacking access to an improved sanitation system. These data are provided by the JMP, which assesses these percentages from a facilities point of view, but does not provide data on the actual sanitation of these and the real quality of the resource consumed. Therefore, there is a need for research and use of other indicators that can provide more in-depth information aimed at identifying real local problems and needs.

Objectives
The aim of the research work was to analyze the water and sanitation system of Vilankulos city using specific synthetic indicators and to verify their adequacy.

Activities
The analysis of the drinking water and sanitation system was carried out through a field phase and a data processing phase.
Regarding activities on the ground, interviews were conducted with local stakeholders and questionnaires to the population aimed at collecting qualitative data on water and sanitation habits and knowledge of existing facilities. These data were complemented by an extensive microbiological water quality monitoring campaign.
The data were processed using a number of indicators known from the literature and adapted to the case study, such as the *Water Poverty Index (WPI)*, the *Sanitation Poverty Index* (*SPI)* (linking water and sanitation conditions with poverty conditions), the *Sanitary Inspection (SI,* proposed by the WHO, to assess the state of water supply facilities) and the water supply chain recontamination indicators (to assess the actual state of the resource at the time of consumption).

Results
The recorded situation showed that conditions in Vilankulos are far from the compliance limits set by national legislation and the WHO. In fact, approximately 30% of the population is supplied from unimproved sources, such as open wells and surface sources that are heavily microbiologically contaminated. In addition, even many sources defined as improved were found to be contaminated, and often the contamination was found to be greater at the point of consumption due to the inadequate hygienic habits of the population about the transport and storage of water. The sanitation situation was also found to be critical as 75% of the population did not have access to improved facilities.
The analysis using indicators such as the WPI and SPI made it possible to identify, within the municipal area, which areas were the most vulnerable and which specific critical issues should be addressed. These tools are therefore considered suitable for use in the planning phase of activities. The IS analysis, on the other hand, showed that the factors affecting the water quality of a source, whether it is improved or not, cannot disregard the context in which it is located, so this index is not suitable for comparing very distant realities. Finally, the analysis of the water supply chain showed a clear deterioration in the quality of water from the source to the point of consumption, and the 'time needed to transport water' and the 'way in which it is stored' were identified as the most critical factors, showing the need for awareness-raising and hygiene education interventions, without which technical improvement actions on water supply sources alone would be futile.

Future developments
Carry out awareness-raising and hygiene education for safe transport and storage.

Name Surname: Beatrice Coloru

Cycle: XXVI – 2010/2011

Tutor: Sabrina Sorlini

Title: Sustainability of water supply service models: analysis and assessment of case studies in Tanzania and Senegal

Project location: Tanzania e Senegal

Partner: ACRA

Context and problems
The availability of water for domestic and productive uses is indispensable to the well-being and socio-economic development of a community. In the face of strong global achievements in attaining the Millennium Development Goals, practitioners still face the challenge of ensuring the universal right of access to water and doing so in a sustainable manner.

Objectives
Analyzing water supply systems in rural settings from a sustainability perspective and supporting decision-making processes to identify appropriate management models. In addition, the thesis addresses the problem of methodological gaps in the sustainability assessment of water supply and basic sanitation projects due to the multidimensionality of the sustainability concept, the complexity of projects and the lack of resources and expertise available to development practitioners, especially in the ex-post phases of projects.

Activities
The activities aimed at achieving the objectives involved two projects implemented and managed by ACRA (Association for Rural Cooperation in Africa and Latin America) in Tanzania (Zanzibar and mainland): a) Pro-poor tourism strategies in Burkina Faso, Ecuador and Tanzania', aimed at improving the economic conditions of communities through access to the tourism market in Zanzibar, in a context of environmental and cultural sustainability: the project includes an environmental component aimed at creating decision-support tools for solid waste management at the local level. The planning and implementation of activities related to this component involved literature research, data collection and consultation with local stakeholders. The process could represent a case study of interest, especially due to the peculiarities of the context. B) "Access to safe water in the District of Njombe, Iringa Region": a project for the supply of water in rural areas by means of a gravity adduction system, within which several research components are envisaged.

Results
The case studies presented demonstrate that the assessment of the level of service provided, the estimation of lifecycle costs in relation to available or potentially available resources can be carried out in a simple and inexpensive manner and yet allow plausible considerations of project sustainability. The case studies described allow for an assessment of the implications of technologies on the social, financial, and institutional dimensions of sustainability and the identification of measures at the level of the regulatory and institutional framework, which allow for the risks to be minimized and the opportunities associated with a given technological option to be enhanced.

Future developments
The concept of appropriate technologies, although closely linked to that of sustainability, is not sufficient to guarantee the indefinite permanence of the benefits of water supply and sanitation projects.
Since infrastructures are often already in place and technological choices imposed by governments, financiers and hydro-geological constraints, there is a need for a systemic approach, aimed at changing the social and institutional context to ensure the sustainability of a given technology.

Name and surname: Luca Rondi

Cycle: XXVI – 2010/2011

Supervisor: Sabrina Sorlini

Title: The Water Safety Plan approach: elaboration, implementation and evaluation in rural contexts of sub-Saharan Africa

Project location: Burkina Faso

Partners: Medicus Mundi Italia, Fondazione Tovini, Fondazione Sipec, Associazione DAKUPA (Burkina Faso)

Context and problems
Water Safety Plans place emphasis on ensuring that drinking water treatments are effective and operate in such a way that any possible risk of contamination is excluded and that the water delivered to the consumer is safe to drink. In fact, the WSP approach requires that every possible cause of contamination of water intended for human consumption (from the source to the point of consumption) is identified and prevented through the application of specific control measures.

Objectives
The main objective of this research was to apply the WSP approach in two different rural contexts in sub-Saharan Africa, namely in: a) Senegal: where the context was already known due to a previous international cooperation project implemented by the NGO "Fondazione G. Tovini', also responsible for the project through which the WSP was developed. B) Burkina Faso: where the context was completely unknown, and no other international cooperation project had ever involved the local community.

Activities
The WSP approach was developed in two rural contexts in sub-Saharan Africa.
The first processing took place in Senegal thanks to an international cooperation project implemented by the NGO Fondazione G. Tovini (Brescia, Italy), in a rural area with approximately 15,000 inhabitants. About this case study, two field missions were carried out: the first one was entirely dedicated to a contamination risk analysis, while in the second one, the WSP was elaborated, after identifying the team members. At the same time, support programs for the WSP were also developed, based on awareness-raising campaigns and training courses. The second WSP was elaborated in Burkina Faso, thanks to an international cooperation project coordinated by the NGO Medicus Mundi Italy (Brescia, Italy), in a rural area inhabited by approximately 3,000 people. In this case, there were three missions carried out in the field: the first to carry out a risk assessment, the second to elaborate the WSP, in conjunction with the implementation of support programs, while the third was completely dedicated to assessing the situation on the ground (regarding drinking water management practices) after the implementation of the WSP.

Results
A simplified WSP approach has also proven to be effective as an awareness-raising tool for local communities. In the rural villages of Fingla and Diarra (Burkina Faso), the WSP was developed during an awareness-raising program on good community and household practices for drinking water management. The community was asked to list all possible causes of water contamination along the entire supply chain and to identify the most effective control measures (in conjunction with the identification of a monitoring program) to prevent, or at least minimize, contamination risks. The cost-time analysis carried out in both case studies revealed a strong dependency between the cost and time required to develop a WSP and the complexity of the water supply system. The presence of a strong local partner (such as an NGO) proved to be a reason for success in the implementation and sustainability of a WSP.

Future developments
Although risk analysis is a very important step in the development of the WSP, it also turned out to be the most expensive one. Furthermore, the (physical) presence and (working) availability of a laboratory must also be taken into consideration. This should preferably be close to the intervention area, to be able to carry out the microbiological analyses in an appropriate time frame and should be well equipped (in terms of instrumentation and reagents) to perform chemical analyses. For these reasons, a cost-benefit analysis should be carefully carried out, in order to assess the amount and type of analyses that should and/or could be performed depending on the funds available.
In both case studies, the sustainability assessment was conducted at the end of the project. However, a long-term evaluation (after 1, 5 or 10 years) should be carried out to truly understand the effectiveness of the WSP over time.

Name Surname: Marco Caniato

Cycle: **XXVI – 2010/2011**

Tutor: Mentore Vaccari

Title: Study of health and environmental risks associated with medical waste management and development of appropriate technologies for its recovery and disposal

Project location: Gaza Strip

Partner: COOPI

Context and problems
The management of medical waste is a particularly complex issue for countries with limited resources, given the plurality of skills and resources required (regulatory, organizational, managerial, technological, financial) and actors involved. In the Gaza Strip, the situation is exacerbated by the diplomatic-political context and the blockade imposed by Israel since 2007, which restricts access to energy and devices/technology (e.g. machinery, equipment, spare parts, consumer goods). Therefore, the management of medical waste is deficient throughout the entire chain, from management in health facilities to transport, treatment, and disposal.

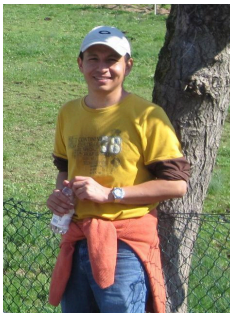
Objectives
Analysis of the subject matter and in particular the critical issues related to the proper and safe management of medical waste throughout the supply chain in a resource-limited country, reducing the risks to occupational, patient, and public health and the environment. Identification of concrete actions to promote a management system in the case study and support their implementation in collaboration with the partner and local counterparts. Evaluation of the system introduced, with the aim of identifying an intervention methodology that allows local institutions the continuation of the actions initiated independently, as well as their replicability in other contexts.

Activities

The issue was initially studied through fieldwork in Thailand in collaboration with EAWAG and AIT, with a focus on the management system and the roles of stakeholders. These aspects were discussed and explored in depth with several Italian and international experts, and with staff from the Spedali Civili di Brescia and lecturers from Northampton University.
The fieldwork started with a study of the overall solid waste management in the Gaza Strip, accompanied by a detailed study on medical waste. Then, an intervention proposal was developed to introduce a management system within the second largest hospital in the Strip, also proposing actions to improve the performance of the incinerator within the same facility. During the implementation of this intervention, the data collected was shared with all actors active in the area, i.e. public authorities, private health facilities, NGOs, WHO, professionals, highlighting further critical issues.

Results
Preparatory activities showed the complexity and multidisciplinary nature of the issue and the need for in-depth study before proposing corrective actions. In particular, a methodology for analyzing an environmental management system and its actors was developed, combining stakeholder analysis and social network analysis. This methodology was first tested in Thailand and then applied in Gaza. Thanks to this study, the intervention succeeded in involving all relevant actors, gaining interest and support. The unstable political and security situation (II Gaza War during the intervention) hindered the intervention, which nevertheless showed how interesting results can be achieved in a short time in terms of introducing alternative practices and technologies, optimizing processes, and involving actors.

Future developments
The partner's intervention in Gaza stopped after the intervention for bureaucratic and financial reasons. However, an ex-post evaluation revealed the need for further action to support the changes introduced and to act on the various steps in the supply chain. The literature study and several discussions with various experts at the international level highlighted the need for similar actions in many resource-limited countries.



Name Surname: Franco Hernan Gómez Tovar

Cycle: XXV – 2009/2010

Tutor: Sabrina Sorlini

Title: Integrated wastewater management in the suburbs of Ciudad Guayana - Venezuela

Project location: Ciudad Guayana - Venezuela

Partner: Servizio Volontario Internazionale SVI – Brescia

Context and problems
The research is developed in the Moscú district located in the outskirts of San Felix in Ciudad Guayana (Republica Bolivariana de Venezuela). The work carried out so far has been developed as part of the research activities of CeTAmb (Centre for Documentation and Research on Appropriate Technologies for Environmental Management in Developing Countries) in collaboration with the Italian NGO Servizio Volontariato Internazionale di Brescia (SVI), the local partner Centro de Formación Guayana (CFG) and a women's group called Salud para-Guyana (Sapagua). The research began with a technical visit to provide an overview of the environmental and territorial situation in the area. The most significant problem was that of black and grey water management. The current sewage network does not guarantee coverage of the entire neighborhood, as is the case in many Latin American cities.

Objectives
Developing appropriate technological and methodological solutions to solve the environmental problems encountered in the neighborhood, with particular attention to grey water. These proposals must be accompanied by education and awareness-raising activities aimed at the neighborhood community on environmental and health issues, having found that organizational and community conditions exist that are useful for developing pilot and experimental initiatives.

Activities
The research activity was divided into 3 phases: a) territorial and environmental analysis of the neighborhood, carried out at the end of 2010; b) study of appropriate technologies to define a sustainable proposal; and c) implementation and monitoring of the proposed technology in the neighborhood under consideration.

Results
The study area has an area of 12,000 m^2, a population of 75 families living in 69 houses. The population is divided into 153 adults and 151 children. 64% of the houses are built using zinc sheets. People have a low income and health services are precarious. All homes in the district are connected to a drinking water distribution system from the Caroni River, which is then treated by coagulation, flocculation, sedimentation, sand filtration and disinfection with chlorine. Regarding black water, only 13% of households are connected to the sewerage system, 63% of households have water toilets connected to leaking pits in the ground, 24% of households have no sewage system at all. In 52 households the grey water (from sinks, showers, washing machines) produced is spread on the streets without any control. The population suffers from episodes of diarrhea, stomach pains, intestinal parasites. This is confirmed by the presence of coliform bacteria in the water for human consumption.

Future developments
For the selection and implementation on a pilot scale of the treatment considered most appropriate for grey water treatment, activities will cover chemical and microbiological analyses of grey water, the study of the advantages and disadvantages of different technologies, and the design, construction, and monitoring of the experimental pilot plant for the treatment of grey water at household level. In addition, appropriate forms of disposal and recovery will be identified. Awareness-raising and community education activities will be carried out for the proper management of the pilot plant. For black water, the activity is aimed at improving the current black water management system to reduce the health and hygiene risks to which the population is exposed. The activities will concern chemical and microbiological analysis of the discharges, the study of a simple system for improving the models present and currently in use in the district, and the identification of systems for reusing the sludge produced.

Name Surname: Riccardo Bigoni

Cycle: XXV – 2009/2010

Tutor: Sabrina Sorlini

Title: Drinking water disinfection using a linear parabolic trough solar concentrator

Project: Baboné (Cameroon)

Partners: ADA Onlus (BS), I.S. “C. Golgi” (BS), I.T.I. “G. Galilei” (MN), Ditta Radice (CO), Universitá di Dschang (Cameroon)

Context and problems
In developing countries, the problem of microbiological contamination of drinking water is one of the main factors affecting the health of populations. This research aims to address the problems associated with the difficult access to drinking water sources by populations living in rural areas in the West Cameroon region.

Objectives
The project involves the design and installation of a linear parabolic trough type solar concentrator, capable of raising the temperature of the water contained within the pipe passing through the focus of the dish, to the complete inactivation of pathogenic microorganisms in the water entering the system. The research has the following objectives: a) design, construction and monitoring of a pilot solar concentrator; b) identification of an appropriate site for the installation of a concentrator in a rural context in the West Cameroon region; c) design, construction and monitoring of a water treatment system consisting of a pilot solar concentrator to carry out water disinfection in the village of Baboné; d) awareness-raising of the population on the problems related to poor drinking water quality.

Activities
Initially, the use of the solar concentration system was studied and adapted for application as water treatment in developing countries. Eight modules of 1 m length and 2 m width each were constructed in parabolic iron to set up the first pilot concentrators. Once the experimentation phase in still water conditions was completed, a new 5 m long pilot concentrator operating in moving water conditions was set up on the roof of the Faculty of Engineering of the University of Brescia. In addition to the experimentation phase in Italy with the pilot concentrators, two missions were carried out in the village of Baboné to carry out a survey of the social and territorial context for the installation of a solar concentrator, a survey of the water resource in the area under examination, and some analyses of the physical-chemical, chemical and microbiological quality of the water used for drinking water purposes.

Results
The solar collector can heat a volume of 1 L of water in less than 10 minutes and achieve excellent disinfection yields when the water is heated to a temperature of 85°C for at least 2 minutes. On-site investigations revealed the absence of a distribution and treatment system for the water, which was already found to be contaminated at source. The geographical location, the constant presence of water throughout the year and the availability of materials for the construction of a solar concentrator make the use of a solar concentrator to disinfect the water suitable.

Future developments
Consequently, future phases of the project will involve the definition of all system components for future full-scale application, the fabrication, shipping, and installation of a pilot solar concentrator in the village of Baboné, and the monitoring of the installed concentrator. Finally, a training phase is planned for the local staff in charge of operating the concentrator once it is up and running.

Name Surname: Daniela Giardina

Cycle: XXIV – 2008/2009

Tutor: Sabrina Sorlini

Title: Critical approach to sanitation provision in post-emergency situations: considerations for sustainable reconstruction

Project location: Haiti

Partner: CESVI Fondazione Onlus

Context and problems
In emergency situations, humanitarian agencies have a mandate to respond to basic needs, especially when the state lacks the capacity to handle complex situations. When disaster strikes, large numbers of people are forced to displace and organize themselves in spontaneous, often overcrowded camps, with little access to good quality water supplies and adequate sanitation. Typhoid and other diarrheal diseases have a greater risk of spreading when adequate facilities and hygiene are not respected. The research is a collaboration with CESVI, a non-profit foundation based in Bergamo, in response to the 7.0 ML earthquake of 12 January 2010, which devastated Haiti's capital, Port-au-Prince, and the western region of the island, causing the death of more than 200,000 people and the displacement of more than 1.3 million.

Objectives
The research aims to highlight the difficulties faced by humanitarian responses in laying the foundations for the provision of sanitation systems that ensure long-term sustainability. To achieve this, the research aims to:

1. Examine current approaches used for sanitation provision in development interventions and in emergency response, highlighting their differences.
2. Identify the main critical issues for the integration of sustainability factors for the implementation of such interventions in the post-emergency/reconstruction phase (Haiti case study).

Propose strategies that can be applied in post-emergency to reduce and mitigate the risks of further disasters.

Acitivities
An environmental and sanitation assessment was carried out in the towns of Grand-Goave and Petit-Goave, west of the capital, aimed at identifying the main actors: institutions, international agencies, humanitarian organizations, and their roles, and providing technical guidance for the construction of emergency latrines in IDP camps and the construction and rehabilitation of existing latrines in some primary and secondary schools in Petit-Goave and Grand-Goave. The field mission made it possible to analyze critical issues in technological, environmental, social, and cultural, economic, and financial, and institutional terms. The types of latrines built by the main international organizations were analyzed, and a comparison was made of the technological choices adopted. The conditions influencing the choice of technology were identified: difficulty of finding water; unavailability of qualified operators; lack of sludge treatment plants; high water table (4-5 m above ground level); high risk of groundwater contamination with existing systems; high temperatures throughout the year and the presence of rainy seasons. The double pit type was selected as pilot technology, with urine drainage in a planted evapotranspiration tank.

Results
In emergency situations it is much more complex to include long-term sustainability criteria, but some common approaches can be identified. For example, providing appropriate support to schools can ease the transition between the emergency phase and the reconstruction/development phase. Following these missions, some mitigation measures are being defined, especially for schools that can be implemented during the reconstruction phase, promoting vulnerability reduction, and strengthening local capacities.

Future developments
Since Haiti is threatened by natural disasters a disaster risk reduction and contingency plan should be developed for schools to be able to support displaced persons seeking shelter after the disaster. A stock of emergency supplies should be included, including the provision of additional sanitation facilities to avoid overloading and thus support the re-start of school activities.

Name Surname: Francesco Vitali

Cycle: XXIV – 2008/2009

Tutor: Mentore Vaccari

Titolo della ricerca: Appropriate technologies for the utilisation of domestic energy resources in the Logone Valley

Project location: Bongor (Chad)

Partner: ACRA

Context and problems
Chad, the country where this research project is implemented, is one of the poorest and most backward nations in the world, with a development index of 0.295, which places it 163rd out of 169 countries analysed. Situated in the middle of the Sahelian strip, the problem described above is felt particularly strongly both by the natural environment, which is experiencing an increasingly rapid depletion of forest resources, and by the population, which still uses cooking systems based on the use of traditional braziers, such as the '3-stone' fire.

Objectives
Identification and development of context-appropriate technologies to produce primary energy at the household level: on the one hand, the need to improve the efficiency of traditional combustion systems by comparing different technological options is investigated, and on the other hand, the introduction of new solutions, which allow the valorization of alternative waste energy sources, is tested. The impact on and acceptance by the local population are indispensable elements in assessing the appropriateness of the proposed technologies; focusing on their influence on the success of a development cooperation project is one of the objectives of the research.

Activities
The comparison of locally available stove-ovens is one of the activities carried out on site: it is necessary to assess which model is the most appropriate to the local reality from multiple points of view (energy efficiency, time and quantity of fuel required, reproducibility and adaptation to local practices, etc.).
As part of the search for possible alternative solutions, the experimentation of a stove model proposed by CeTAmb using waste biomasses that are difficult to fuel was implemented: in particular, the availability of significant quantities of rice husks during the harvest season was detected on site. This biomass currently has no use or market and is therefore discarded by local farmers. During on-site missions, prototypes of this model were made and tested with local materials.

Results

As part of the comparison of different types of braziers, the validity of the Central African model, the dissemination of which the project promotes, was verified through tests of both boiling and cooking food according to local practices. A group of women was also trained in the construction of improved clay braziers, which guarantee a reduction in wood consumption thanks to minimal insulation of the combustion chamber compared to the traditional '3-stone' model. The on-site construction of a biomass stove prototype, according to the project previously carried out at the laboratories of the University of Brescia, made it possible to overcome the difficulties in finding materials, developing alternative solutions that were more economical and applicable to the local context, while maintaining good results on the energy efficiency of the proposed technology.

Future developments
During the last mission, the continuity of stove production by the trained artisans was verified (over 3500 wood-burning stoves produced by 20 artisans) and their use by the local population in daily cooking practices. An objective assessment of the impact of the intervention from various points of view (environmental, health, socio-economic, etc.) could provide an important boost for the dissemination of the proposed models on a larger scale, reaching a wider segment of the population. A development phase is currently underway in order to improve its applicability to the local context and reliability in performance.

Name and surname: Christian Zurbrügg

Cycle: XXIII – 2007/2008

Supervisor: Carlo Collivignarelli

Title: Assessment methods for waste management decision-support in developing countries

Project location: Switzerland, Ethiopia, Indonesia, Thailand

Partners: Eawag/Sandec, Switzerland; AIT, Thailand

Context and problems
Low and middle income countries decision-makers face a dire situation as facilities and services in solid waste management are dysfunctional and cannot keep up with rapid urbanisation. It is a recognized priority by policy makers and local governments to tackle this issue and find ways to manage urban waste in an economically sustainable way without compromising environmental goals. Projects, must have an objective of durability and robustness to adapt. This requires careful planning not only at the outset of implementation, but continuously during the operation. Furthermore provisions for sustainable financing (covering investment, depreciation, operation & maintenance and replacement cost) are key to ensuring a robust and reliable operation and maintenance.

Objectives
The research is based on the Integrated Solid Waste Management (ISWM) approach which is comprehensive and considers how to prevent, recycle, and manage solid waste in ways that most effectively protect human health and the environment. Assessment methods and their appropriateness are studied for this research. These include: Life Cycle Analysis (LCA) or Technology Assessment (TA), stakeholder analysis (SA) and social network analysis (SNA). Goal of the research work is to further advance on a package of tools and develop and validate a simple but effective way to assess existing projects and plan for new projects in solid waste management of low and middle income countries. This simplified method and shall allow, through a series of questions, to provide the basis for an analysis of the "drivers of success" or respectively the "reasons of failure".

Activities
A first overview of methods was obtained through literature and report research. Results of the research are described below. A first draft of an assessment tool was then developed which follows a guiding set of questions covering the different "sustainability domains" which can be summarized as: technology, social aspects, economy, institutions, and environment (figure 1). Some questions refer to a hypothesis on how a specific issue may affect success of the project, others assess impact of the project - typically on the environment. This tool was applied on an existing case in Indonesia which refers to organic waste composting.

Results
The overview shows that typically, Life Cycle Analysis (LCA) is a well established and widely used method also for solid waste projects. This is a technique that aims at addressing goods and services their use of energy materials and resources in their whole life cycle (i.e., cradle-to-grave) and their potential environmental impacts. Impacts of interest are energy consumption, production of solid wastes, emissions of regulated air pollutants and water or soil pollutants. Moreover LCA and associated methods do not give an indication how the product quality or projects performance (i.e. success) is affected by the specific contextual conditions as summarized under the term "enabling environment". Results of an assessment using the newly developed tool for a project on organic waste composting in Bali, Indonesia was published in a paper and presented at the WasteSafe Conference in February 2011 in Khulna, Bangladesh.

Future developments
In a next step the tool shall be further validated in a project on health care waste incineration of Bangkok, Thailand. The methods of assessment that are further developed and shall be used are those of stakeholder analysis and social (stakeholder) network analysis. Furthermore research is on-going to test a multi-stakeholder weighting procedure based on Analytical Hierarchy Process (AHP). Further research on sustainability factors for anaerobic digestion shall be analysed for the specific context of Bahir Dar in Ethiopia. Finally two publications are foreseen on: a) factors of success in small Indian composting units and b) elements of process cost accounting for decentralised composting in Eritrea.

Name Surname: Daniela Palazzini

Cycle: XXIII – 2007/2008

Tutor: Sabrina Sorlini

Title: Sperimentazione di tecnologie appropriate per la potabilizzazione dell'acqua di falda e la rimozione dei fluoruri in Senegal

Project location: Senegal, Diourbel region, rural community of Patar

Partner: Cheikh Anta Diop University of Dakar

Context and problems
In the Diourbel region, groundwater contains high concentrations of fluorides, above the Guideline Value (GV) of 1.5 mg/L indicated by the WHO for drinking water consumption. In the rural community of Patar, there is a network system that distributes water to 30 villages in the rural community, where approximately 13,000 inhabitants live (in 2006). The concentration of fluorides in the distributed water varies from 5 to 7 mg/L and no removal treatment is applied. Many people in these communities suffer from dental fluorosis.

Objectives
The main objectives of the research and the cooperation project in which it is embedded are:
- the improvement of the quality of water consumed for drinking purposes by the population.
- the strengthening of local capacities in terms of water supply system management.
- dissemination of information on the health effects of consuming poor-quality water.

Activities

1. monitoring the quality of water sources exploited by the population; 2. Design, experimentation and implementation of domestic borehole water treatments (filtration on animal bone ash for fluoride removal: 2 bone calcining kilns, 1 pedal-driven shredder for crushing bone ash from the kiln, and 70 bone ash filters were built; a rainwater collection tank was built at prototype level; disinfection tests to compare chlorine and solar disinfection); 3. Training courses for the women beneficiaries of the filters and for village technicians on the operation of the systems built as part of the project; 4. Training courses for Dakar University students on drinking water management and related issues.

Results

(a) a filter filled with approximately 2 kg and 6 kg of bone ash with grain sizes 2-4 mm (at the base) and 0.2-2 mm, respectively, under free-flow conditions and a contact time of 8-10 min, has a service life of 2 to 3.5 months following treatment of 50 L/d of water with an inlet concentration of 5-7 mg/L fluorides; the high concentration of chlorides and sulphates does not significantly affect the fluoride removal yield by the bone ash; (b) borehole water, although microbiologically pure at source, is subject to a progressive increase in bacterial contamination during transport, domestic storage and treatment through the bone-ash filter (if this is fed with contaminated water); c) the organoleptic quality of the water is altered following treatment with non-calcined bone ash at the optimum temperature of approximately 500°C; d) an active chlorine dosage of 4.2 mg/L with a contact time of 30 min allows for a complete abatement of E. coli and enterococci in the water leaving a filter. Solar disinfection also demonstrated near total removal yields after exposure of the water to the sun for 24 hours. In terms of the applicability of the two techniques, it was found that chlorine is readily available from the village but at a cost not sustainable for long-term use, while plastic bottles are not available from households.

Future developments

Evaluation of the quality of rainwater stored in the prototype tank and dissemination of the dilution technique to village households; microbiological monitoring to detect and quantify contamination during the water supply cycle and to clarify the evolution of microbiological quality during filter use; continuation of disinfection tests and selection of the best water treatment technique to be implemented; experimentation on the use of activated carbon produced from coconuts to be inserted as a final filtration stage to remove the color released by the bone ash; implementation of a Water Safety Plan (WSP).

Name Surname: Veronica di Bella

Cycle: XXIII – 2007/2008

Tutor: Mentore Vaccari

Title: Research on appropriate waste management technologies in low-income countries and limitations in their application - Case studies from Somaliland

Project location: Somaliland

Partner: ONG Cesvi

Context and problems

In urban areas, and in fast-growing cities in low-income countries, systems for the collection, recycling and disposal of solid waste are almost always technically, economically, and financially unsatisfactory. These problems are very evident in a context such as Somaliland, where at the beginning of the project the waste management system was almost non-existent.

Objectives

The research aimed to assess the practical limits of technical solutions to improve waste management in low-income countries. The study looked at three different areas: disposal of municipal solid waste, treatment of hospital waste and recycling of inorganic waste such as paper and plastic.

Activities

Research activities took the form of designing sanitary landfills in five cities in Somaliland (Hargeisa, Boroma, Burao, Gabiley and Sheikh) using local technicians, labor and materials, and conducting training courses. The issue of hospital waste treatment was addressed by constructing three small

incinerators in three major hospitals in Hargeisa, the capital of Somaliland, and in conducting technical courses aimed at presenting the correct operation of the incinerators and practices for waste separation. Meetings were organized to make participants aware of the dangers of certain types of waste. A study was carried out to assess from a technical point of view the recycling possibilities of certain inorganic waste fractions, such as paper and plastic.

Results
The solution identified consists of the construction of sanitary landfills from scratch or the gradual transition from garbage dumps to sanitary landfills, considering local characteristics, such as the low presence of organic waste and the aridity of the area. These characteristics made it possible to simplify leachate collection and treatment systems, limiting them to channels that flow into an evaporation basin, and to avoid the construction of biogas collection works. The main problems encountered in the construction phase of the landfills were: the scarcity of land; technical difficulties; the availability of obsolete or poorly maintained vehicles needed to carry out the works; and the lack of cooperation from the local municipality. As far as hospital waste is concerned, the incinerators constructed are of the 'De Montfort' type, suggested by the World Health Organization, and have a capacity of 12 kg/h. During the construction of the first of the three structures, problems were encountered in the compactness of the structure, which was built with refractory bricks; therefore, the other two incinerators were built using local stones, which showed good resistance to high temperatures. Other problems were encountered in the operation of the incinerators, in one of the three hospitals; these difficulties are attributable to the lack of supervision and control within the facility, which leads to irregularities in the operation of the incinerator and its cleaning. Overall, the intervention has had positive effects, leading to a tangible improvement in the management of hospital waste that was previously burned openly or collected with municipal waste in an indistinct manner.

Future developments
This could include monitoring the landfills that have been built and repeating the training courses that have been conducted, checking the operation of the incinerators that have been built, and extending the hospital waste collection and disposal service to other facilities in the city. Economic investigations should be made to assess the feasibility of a plastic recycling plant.

Health Track

Name Surname: Virginia Quaresima

Cycle: XXXII – 2016/2017

Tutor: Prof. Francesco Castelli

Title: Are malaria risk factors based on gender? A mixed-methods survey in a malaria holo-endemic country in Western Africa

Project location: Ghana

Partners: HopeXchange Medical Centre (HXC), Kwame Nkrumah University of Science and Technology (KNUST)

Context and problems
Kumasi is a large city (the second most populous in Ghana, after the capital Accra) located in the central-southern region of Ghana, the so-called "Ashanti" region, where malignant tertian malaria caused by P. falciparum is endemic. In recent years, Ghana has seen an increase in reported cases of malaria caused by Plasmodium falciparum, rising from 926,447 in 2010 to 4,505,442 in 2016. Data on the non-pregnant adult population, however, are scarce and inconclusive, often deduced from absolute numbers of hospitalized cases without information on the denominator and any concomitant factors. For these reasons, the World Health Organization recommends studies with disaggregated data by gender to better understand the phenomenon. Differences in the incidence and severity of malaria could be due to: (i) intrinsic biological factors, (ii) different exposure, or (iii) socio-cultural factors.

Objectives
Based on WHO recommendations, this research project aimed to study malaria from a gender perspective in the city of Kumasi, Ghana. The main objectives of the study were: (i) to assess how symptoms and laboratory parameters in adult cases of *P. falciparum* malaria differ by sex in an area that is highly endemic; (ii) to identify factors influencing malaria exposure behaviors for adult women and men in a highly endemic area. As a

secondary objective, gender dynamics within households were studied to examine and understand behaviors related to self-treatment and access to care regarding malarial infection.

Activities
This study was conducted between June and October 2018 at the HopeXchange Medical Center (HXC), a small 50-bed hospital located on the outskirts of Kumasi. The project employed a combination of qualitative and quantitative research methodologies. Qualitative methods used in the study included focus group discussions and face-to-face interviews. Participants, divided by gender, discussed various aspects related to malaria, guided in the discussion by a research assistant from HXC who spoke the local language (Twi). In addition, fifteen interviews involved hospital staff, specifically queried about daily habits aimed at increasing or reducing mosquito bites or commonly employed malaria prevention methods. Quantitative methods were based on prospective enrollment of adult subjects diagnosed and treated for malaria at the HXC center. Among the quantitative methods, a case-control study was also conducted, during which healthy adult controls who had lived in the same household as the malaria-diagnosed patient (case) during the 30 days preceding the diagnosis were enrolled, excluding pregnant women.

Results
124 individuals were diagnosed with malaria at HXC and enrolled in the research project. Compared to the national figure, which reports a mosquito net usage rate of 57%, this study found, on the contrary, a low percentage of individuals owning (40%) insecticide-treated mosquito nets, and an even lower percentage of individuals consistently using them (19%). The majority of enrolled malaria patients were women, with lower levels of education and higher exposure to mosquito bites.

Future Developments
The disease was not only analyzed from a clinical perspective, but also considered risk factors related to mosquito exposure and preventive measures employed. The study unexpectedly discovered reduced mosquito net usage and a high tendency towards self-treatment among the enrolled individuals. The study highlighted the need to invest in future malaria control strategies and research methodologies more focused on the social and behavioral aspects of people, rather than solely concentrating on biological or clinical factors.

Name Surname: Valentina Marchese

Cycle: XXXI – 2015/2016

Tutor: prof Francesco Castelli/**co-tutor** Prof. Alberto Mattelli

Title: Early detection and integrated management of tuberculosis in Europe" with a focus on migrants

Project location: Brescia (Italy)

Context and problems
According to the International Organization for Migration (IOM), the United Nations migration agency, 70% of the 171,635 migrants and refugees who arrived in Europe by sea in 2017 disembarked in Italy. In 2016-2017, the number of migrants arriving in Italy was 300,805, despite a decrease observed in arrivals during 2017 (34.2% less than in 2016). Most migrants come from countries with an estimated tuberculosis (TB) incidence exceeding 150/100,000. Available data on TB (both active and latent) in migrants are scarce and fragmented. Identifying the best screening and early detection strategy for TB in migrants is still a subject of discussion and evaluation.

Objectives
To create a network with local healthcare operators to develop a TB screening protocol for migrants. To establish systematic screening for active TB in migrants in first-level temporary reception centers. To initiate active and latent TB screening activities in second-level reception centers in Brescia. To collect data and produce evidence useful for future European policies.

Activities
We conducted a retrospective analysis of active TB and latent tuberculosis infection (LTBI) screening carried out among asylum seekers in the Brescia area in 2015-2016, evaluating incidence and prevalence rates, as well as

screening and treatment completion rates. Together with project partners, we designed an application for recording and collecting screening data (EDTapp), which was used and evaluated both upon initial arrival (Sicily) and in second-level centers in Brescia. In the prospective phase, we assessed the impact of changes in screening delivery methods on completion rates.

Results
Retrospective analysis of active TB and latent tuberculosis infection (LTBI) screening in relocated migrants in Brescia: the calculated prevalence and incidence of TB were 545/100,000 person and 220/100,000 cases/year-person, respectively. Losses during screening and LTBI treatment were high and mainly attributable to fragmentation of the screening service delivery system. Active TB and LTBI screening among asylum seekers relocated to Brescia since 2017 were conducted using a new (centralized) service delivery system and showed higher completion rates. The application for recording and collecting TB screening data showed overall high satisfaction levels (4.9), with positive feedback on the training provided and potential future applications (4.0 and 4.7, respectively).

Future Developments
Given the prevalence and incidence of active TB and high rates of LTBI, there is a need to implement new active TB screening strategies (by introducing chest X-rays) and LTBI screening strategies that facilitate completion. Considering the poor resilience demonstrated during periods of high influx, the healthcare system should develop prompt response plans for migrant flows, which are subject to sudden changes and consequent variations in related public health needs. Centralization of interventions appears to improve screening uptake for LTBI, while adopting short treatment regimens could improve therapy completion rates. New treatment and screening types will be evaluated in the same area, including new therapeutic regimens, as well as cost-effectiveness assessment of currently available screening strategies. The application has proven reliable and received positive feedback from users in the pilot phase, but further evaluations will be necessary during implementation on a larger scale.

Name Surname: Liliana Maura Praticò

Cycle: XXX – 2014/2015

Tutor: Francesco Castelli

Title: Perception of the educational environment and students' attitudes towards international cooperation in health faculties of two Italian universities

Project location: Brescia (Italy)

Partner: Università di Pavia

Context and problems
The educational environment is a key element for learning. The educational context in health faculties is highly competitive and stressful, often not conducive to student-centered learning that facilitates personal and professional growth. Global health and international cooperation are as important in healthcare as they are often neglected and typically not included in the traditional curricula of medical and nursing faculties.

Objectives
1. To compare the perception of the educational environment in the faculties of medicine and nursing at two universities in northern Italy and assess the interests/knowledge of students regarding international cooperation in these faculties.
2. To identify critical areas of the educational context at individual universities for potential improvement interventions; identify possible factors (sociodemographic, educational) that may influence the perception of the educational context and the interests in international cooperation in the faculties under consideration at the two universities.

Activities
Administration of two questionnaires to students in the faculties of medicine and nursing at the universities of Brescia and Pavia. The first questionnaire is an internationally validated tool on students' perception of the educational environment in health faculties (DREEM = Dundee ready education environment measure); the second questionnaire aims to assess healthcare students' attitudes towards international cooperation. Administration was done via email through the LimeSurvey system, which allowed for centralized sending and reminders. The support of student representatives was crucial in publicizing and increasing student participation.

Results
Participation in the survey was moderate (22% of the general population). Perception of the educational environment: the educational context generally had more positive aspects than negative ones, although none of the five courses analyzed showed an optimal environment. **Critical areas included:** lack of support system for stressed students; study method different from what was learned in high school; authoritarianism of teachers; lack of well-organized schedule; teaching focus more on the teacher than the student. **Strengths included**: confidence in overcoming the current year; socially, having good friends in one's course of study and living in welcoming accommodation; academically, learning about the importance of empathy was a strength especially in nursing courses. Area of healthcare cooperation: limited knowledge in global health; much stronger interest in healthcare cooperation in a more international context, such as in the English-language medicine course in Pavia.

Future Developments
- Establish an active institutional "space" where students can feel free to highlight issues in their course, receive *feedback* from their teachers, and propose interventions.
- Introduce the use of DREEM scores as a means of monitoring and evaluating the educational environment over time.
- Create a stronger *link* between universities involved in cooperation by directly involving students. Additionally, to provide more educational offerings in the field, create opportunities for formal and informal learning on these topics, both within the institutional lecture schedule and at other times.

Name Surname: Carlo Cerini

Cycle: XXIX – 2013/2014

Tutor: Francesco Castelli

Title: The *Brigada Móvel* as a tool in the fight against HIV in Mozambique: estimation of access and adherence to treatment in the rural district of Morrumbene

Project location: Morrumbene (Mozambico)

Partner: Medicus Mundi Italia

Context and problems
In Mozambique, a country ranked 163rd out of 169 countries according to the 2016 Human Development Index, human immunodeficiency virus (HIV) infection affects 11% of adults. In rural areas, much of the population faces significant challenges in accessing diagnostic testing and potential therapy. Medicus Mundi Italia (MMI) has been developing mobile clinics in collaboration with the National Health Service in the Morrumbene district since 2007 to reach the most disadvantaged communities.

Objectives
The integration of rapid HIV testing into the context of mobile clinics proves to be an innovative tool. The project aims to study the impact of HIV diagnosis and subsequent health care provision by the health system on the health of HIV-positive patients in rural communities in the Morrumbene district. Specific objectives of the project are:
▪ Define the prevalence of HIV positivity in the population over 14 years of age accessing HIV testing within the services offered by the Mobile Brigades (BM) in the Morrumbene district;
▪ Estimate the percentage of HIV-positive patients identified by the BM who attend the first visit at reference health centers;
▪ Estimate the percentage of HIV-positive patients identified by the BM who adhere to diagnostic and therapeutic follow-up six months after diagnosis;

▪ Understand the social, economic, and cultural determinants of lack of access and loss to follow-up in the specific context of the Morrumbene district, in order to design concrete intervention strategies.

Activities
Throughout 2016, the results of HIV infection diagnostic tests were recorded in 29 rural communities; each patient with a positive result was administered a questionnaire aimed at understanding their social, demographic, and cultural characteristics. A survey was conducted in all nearby health centers to verify the actual access of patients and their subsequent adherence to antiretroviral treatment.

Results
In ten months of activity, 144 patients were enrolled in the study, predominantly female (93%). Over half of the HIV-positive patients (55%) from rural communities served by mobile clinics do not access health centers to receive treatment following diagnosis of infection. Furthermore, one-fifth of patients who do access treatment do not return for follow-up. Statistical analysis showed that the absence of a steady partner and a large family are limiting factors for access.

Future Developments
Starting in January 2017, an experimental project offering antiretroviral treatment and all services dedicated to HIV-positive patients began in two communities alongside other activities of the mobile clinics. This initiative, unique in the Mozambican context, will ensure essential service for the survival of HIV-positive patients, while also allowing a better understanding of whether this can be a replicable strategy in other districts.

Name Surname: Chiara Poppi

Cycle: XXVII – 2011/2012

Tutor: Francesco Castelli

Title: Prevalence of parasitic infections in a rural population in Ecuador

Project location: Ecuador

Partner: Medicus Mundi Italia

Context and problems
La Manga del Cura is an undefined rural territory in Ecuador, consisting of approximately 62 communities with nearly 60,000 inhabitants. It is an isolated area with limited accessibility to healthcare facilities due to its unfavorable geographical location. The lack of healthcare facilities, poor hygienic conditions, and high illiteracy rates make the inhabitants of this area highly vulnerable to parasitic infections, urinary tract infections, metabolic disorders, and tropical diseases.

Objectives
The presence of two diagnostic laboratories for the most common diseases, water analysis, combined with health promoter training in various communities, will allow for significant and widespread intervention throughout the area. In particular, the study will be conducted on a heterogeneous population of children, and the impact of their health will be evaluated after training sessions for communities and their families. This will help understand whether health promotion can significantly improve the health of children, as well as families and communities.

Activities
The first part of the study consisted of a preliminary survey of 1,121 children who underwent blood and fecal tests, conducted using a mobile laboratory in seventeen communities, including the most isolated ones, to assess the health status and prevalence of parasitic infections and anemia in the area. In the second phase of the study, a subgroup of 562 children underwent blood and fecal tests, and their parents were educated on health prevention. After six months, follow-up analyses were conducted, and a questionnaire was administered

to parents to assess whether participation in prevention sessions had improved children's health through significant changes in family practices. Water analyses were also conducted in collaboration with the Hygiene Department of the Ecuadorian Ministry of Health to assess water contamination.

Results
The primary analysis conducted in 17 communities revealed a prevalence of parasitic infections (predominantly *Entamoeba histolytica* and *Giardia lamblia*) in half of the population, with no presence of co-infection with one or more parasites. Additionally, there was no relationship found between parasitic infections and alterations in hematological indices that could lead to anemia.
In the second phase of the study, analyzing the results of 562 children and their families six months later, a decrease (from 59% to 16%) in the presence of parasitic infections caused by *Entamoeba histolytica* and *Giardia lamblia* was observed, while there was a slight increase in anemia indices (from 11% to 13%). The effectiveness of awareness sessions was demonstrated by an improvement in the use of water in families that attended the sessions, with more families beginning to treat water with chlorine or boil it. Furthermore, it was observed that children from families using treated water had a lower likelihood of contracting parasitic infections.

Future Developments
To confirm the positive outcomes of the study, further health investigations and periodic meetings should be conducted, with more precise monitoring using questionnaires. Collaborations with local schools for continuous awareness on proper water usage and good nutrition, as well as the maintenance of two laboratories on-site, would allow for continued monitoring of other groups of families and their respective health statuses. A recent mission confirmed the continuation of awareness activities and the proper functioning of the laboratory in collaboration with the Ministry of Health.

Name Surname: Silvia Odolini

Cycle: XXVII – 2011/2012

Tutor: Francesco Castelli

Title: Caratteristiche cliniche ed epidemiologiche della malaria da *Plasmodium vivax* nei viaggiatori internazionali provenienti dal Pakistan: l'esperienza del GeoSentinel, The Global Surveillance Network

Project location: Brescia (Italy)

Partners: Infectious Diseases Clinic University of Brescia, Istituto Superiore di Sanità di Roma (ISS)

Context and problems
The aim of the study was to analyze the clinical and epidemiological characteristics of *Plasmodium vivax* malaria in international travelers from Pakistan within the framework of Geosentinel, an international network for monitoring travel-related morbidity and migration. Globally, 3.3 billion people in 97 countries live in malaria-endemic areas. Pakistan, listed by the WHO as a country in the Eastern Mediterranean Region, is recognized as having high endemicity for malaria, with a higher prevalence of *Plasmodium vivax* infection.

Objectives
The primary objective was to describe the trend of imported Plasmodium vivax malaria in travelers from Pakistan, evaluated at European Clinics belonging to EuroTravNet between 2005 and 2012. The secondary objective was to describe the study population based on demographic characteristics, purpose of travel, pre-travel medical evaluation, exposure region in Pakistan, latency period between return date and symptom onset, and adoption of chemoprophylaxis measures. The second part of the study, within the "Viva-Pakistan" study protocol, aimed to obtain information on any peculiarities of Plasmodium vivax isolates identified in patients of Pakistani origin through genetic profiling of this parasite population.

Activities
All clinics belonging to GeoSentinel and EuroTravNet that reported at least 1 case of malaria from Pakistan between January 1, 2005, and December 31, 2012, were included in the study. Detailed descriptive analysis was performed for clinics reporting at least 3 malaria cases. Data were analyzed using Epi InfoTM 3.5. The same statistical model was applied to data collected in Brescia from January 1, 2005, to June 30, 2015. The "Viva-Pakistan" study was conducted in collaboration with the Infectious Diseases Clinic of the University of Brescia and the Italian National Institute of Health in Rome, where blood samples were analyzed to determine the genetic identity of the Plasmodium vivax isolates responsible for the infection. Total DNA was extracted from blood samples using the PureLink Genomic DNA Kit (Invitrogen) following the manufacturer's protocol.

Results
The study revealed an increase in imported cases of P. vivax malaria in patients from Pakistan, particularly those from Punjab, contrary to literature reports. Our data may anticipate a change in the incidence of malaria cases in the Punjab province of Pakistan, an event considered plausible by international organizations. This also has direct implications for our latitudes, as Southern European countries are at higher risk of malaria resurgence, especially P. vivax, due to environmental characteristics, proximity to the African continent with consequent migration flows, and the widespread presence of Anopheles vectors.

Future Developments
The significant increase in P. vivax malaria cases reported in patients from Pakistan, especially from the Punjab region, emphasizes the need for adequate surveillance measures, especially considering the potential risk of indigenous malaria resurgence in areas where competent vectors are present, such as Europe. The data presented in this study highlight the importance of proper utilization of international surveillance networks to continuously update the epidemiology of P. vivax malaria and enable correct diagnosis and therapy in terms of global health.

Name Surname: Alberto Roggi

Cycle: XXVI – 2010/2011

Tutor: Francesco Castelli

Title: TB and TB/HIV in prisons

Project location: Burkina Faso

Partners: Programma nazionale lotta alla Tubercolosi (National Tuberculosis Control Program), Ouagadougou, Burkina Faso

Context and problems
The activities were mainly carried out in Burkina Faso within the technical support framework provided by the University of Brescia to the National Tuberculosis Program (NTP) of the Ministry of Health. Tuberculosis still represents a significant health problem in Burkina Faso. The most affected age group is between 15 and 49 years old, and the prevalence rate is high among the most vulnerable populations. Mortality due to this disease is high among people infected with HIV and often results from a late diagnosis of the illness.

Objectives
The objective was to implement a new molecular biology diagnostic method in Burkina Faso, the Xpert MTB/RIF test, which detects the presence of *Mycobacterium tuberculosis* DNA, the causative agent of the disease, and the possible presence of resistance to Rifampicin, one of the most important and effective drugs used to treat tuberculosis. The use of this test focuses on the most vulnerable and at-risk categories for developing tuberculosis and those with the greatest difficulty in obtaining an early diagnosis so they can be assisted and treated effectively. Specifically, these include people with HIV infection; individuals incarcerated in Ouagadougou prison suspected of active tuberculosis; children hospitalized in pediatric hospitals in Ouagadougou, and patients at risk of multidrug-resistant tuberculosis.

Activities
The laboratory activities using the Xpert MTB/RIF test began after training sessions, which aimed to explain the research objectives, work methodology, sample collection procedures, and the correct use of data collection forms. Sample collection from the centers involved in the study took place over a six-month period. Data collection in an electronic database allowed for comparison of the results obtained with other molecular biology diagnostic methods used.

Results
Regarding the performance of the Xpert MTB/RIF test in our study, defined by comparison with reference diagnostic methods during the activity period, the study results confirm the superiority of the new method over microscopy. Out of the 93 samples belonging to all four categories of patients in the study (HIV-positive individuals, children, prisoners, patients at risk of MDR-TB) that were negative on microscopic examination, 18 (19.3%) tested positive with Xpert MTB/RIF. Particularly in the category of HIV-positive patients, although based on a limited sample of cases, the diagnostic gain with Xpert MTB/RIF compared to microscopy was 100%.

Future Developments
The National Tuberculosis Control Program of Burkina Faso has adopted a policy to expand the use of the Xpert MTB/RIF test, foreseeing its presence in all regions of the country and promoting guidelines that advocate for its use as the primary test in the same populations targeted in the study.

Name Surname: Ernestina Repetto

Cycle: XXVI – 2010/2011

Tutor: Francesco Castelli

Title: Chagas disease in a non-endemic country: the challenge of access to care in Bergamo

Project location: Brescia (Italy)

Partners: Ospedale Sacro Cuore di Negrar, Oikos, Medici Senza Frontiere

Context and problems
To stimulate discussion on the issues surrounding Chagas disease and address the gap in access to diagnosis and treatment in Italy, Médecins Sans Frontières, in collaboration with the Center for Tropical Diseases at the Sacro Cuore Hospital in Negrar and the outpatient clinic for undocumented immigrants OIKOS in Bergamo, has decided to implement a new care model tailored to the Latin American population residing in the province of Bergamo.

Objectives
For the Latin American population enrolled in the screening program, report:
1. Total number of individuals screened and serologically positive for Chagas.
2. Socio-demographic factors and motivation for screening among positive individuals.
3. Number and proportion of positive individuals who initiated treatment.
4. Adverse drug effects and comprehensive outcomes of the care model.

Activities
Health education on Chagas disease, promotion of the screening schedule, and pre-test counseling were conducted by culturally competent mediators of Latin American origin who were specifically trained on Chagas disease and health promotion techniques by the doctoral candidate and physicians from the Center for Tropical Diseases. Following informed consent, blood samples were collected and transported from the OIKOS clinic to the laboratory of the Center for Tropical Diseases on the same day of collection by a specialized transport service. Two ELISA-based tests were used for serological diagnosis. Positive cases were contacted for admission to the Center for Tropical Diseases.

Results
In Italy, when discussing access to care for foreign citizens, one cannot ignore the significant linguistic and cultural barriers that still exist between healthcare providers and potential beneficiaries.
Our care model has implemented a solution to reduce this barrier and has proven effective in ensuring continuity in screenings and building greater trust among foreign citizens towards the Italian healthcare system. This has enabled our target population not only to diagnose and treat Chagas disease but also to receive health education as a preventive tool, which is fundamental and should be more integrated into state health services. In this regard, apart from specific local realities, Italy is still lagging behind other European countries.

Future Developments
Enhance the network of specialized centers in diagnosing and treating emerging diseases in non-endemic contexts and focus efforts on institutionalizing mediation and health promotion services. Establish screening

guidelines for Chagas disease in at-risk blood donors, as in other European countries, and increase early diagnosis in pregnant women of Latin American origin by integrating serological testing among the free exams offered by the National Health Service during routine prenatal checks. Raise awareness among various categories of physicians, from general practitioners to cardiologists and gastroenterologists, as well as other specialists such as rheumatologists or immunologists, who may find themselves treating patients with immune system diseases concurrently with undiagnosed Chagas disease, without being fully aware of its potential risk of reactivation.

Name Surname: Marianna Bettinzoli

Cycle: XXVI – 2010/2011

Tutor: Francesco Castelli

Title: Hygiene and Health: Results of a Community Intervention for Improving Living Conditions of a Population Residing in a Rural Area of Burkina Faso

Project location: Burkina Faso

Partners: Medicus Mundi Italia, Fondazione Sipec, Fondazione G.Tovini, Dakupa

Context and problems
The approach of Primary Health Care implemented in this project aims to increase equity and to respond more appropriately and effectively to the actual health needs by addressing even the distal causes of illness; through a multisectoral, integrated, multilevel intervention involving all stakeholders and the population actively. The methodologies and technologies used must be suitable and adapted to the intervention context.

Objectives
The main objective is to improve health conditions, hygiene, and access to clean water through community interventions in a rural area. The aims are to: a) increase knowledge levels on good practices and improve skills in managing water resources for drinking from the source to domestic use; b) increase knowledge levels on good practices and improve attitudes regarding community, domestic, and personal hygiene; c) enhance knowledge and habits regarding personal and community prevention strategies for identified infectious diseases, aimed at reducing the risk of exposure to the main pathologies present in the intervention area. Additionally, it aims to evaluate the impact of different methodologies on the population's knowledge and attitudes.

Activities
Context analysis, aimed at understanding and identifying the fieldwork needs, was carried out through: questionnaires administered to the general population, students from two elementary schools, their teachers, and water point management committees; microbiological and physical analysis of water; analysis of CO exposure in the population; analysis of health data at the Health Center and District health. Based on the results obtained, health promotion activities were conducted through community sensitization (community meetings, film screenings, theater forum sessions); specific training for healthcare personnel and other community leaders; procurement of supplies for the Health Center and schools, and the construction of deep wells, latrines, and improved stoves. After completing the activities, the same questionnaires were resubmitted to the same recipients to assess the impact of the intervention.

Results
Thanks to this study, we can affirm that: a) a thorough understanding of the intervention context allows finding solutions applicable to the current situation and appropriate to the real problems present, starting from the existing and mobilizable resources on site; b) the involvement of all stakeholders is necessary to implement strategies aimed at improving living conditions; c) a population correctly sensitized to health issues directly affecting them becomes spontaneously involved in social change for the collective well-being; d) awareness of disease risks enables individuals to implement appropriate preventive and/or early therapeutic strategies and suitable for timely management; e) intervention strategies identified directly by the community achieve a better impact, greater collective involvement, and are more appropriate to the action context.

Future Developments
Collaboration with a local NGO is a key element in the success of the activities. In this study, a change in knowledge and behaviors in the short term was evaluated; to study the real impact of the entire project, a study over time would be necessary. When the comprehensive approach to primary health care is implemented, there is an increase in solidarity and cohesion in the fight for one's health. Only by addressing the complexity of reality in an integrated manner and by giving the involved population the tools to become protagonists of the choices that concern them, can we bring about real change aimed at the overall improvement of people's lives.

Name Surname: Anna Cristina Carvalho

Cycle: XXV – 2009/2010

Tutor: Francesco Castelli

Title: Improvement of healthcare in the Morrumbene District (Mozambique) through support for maternal and child health programs and the prevention of vertical transmission of HIV

Project location: Morrumbene, provincia di Inhambane, Mozambico

Partner: Morrumbene Sanitary District

Context and problems
From the indicators of the United Nations Development Program's Human Development Report (UNDP), it is clear that Mozambique is one of the poorest countries in the world. HDI (Human Development Index) data place the country at 172nd out of 177. The main socio-health indicators reported by the UNDP provide a clear picture of the social situation in Mozambique: 69.4% of the population lives below the poverty line, life expectancy at birth is only 41.6 years, 53.5% of the adult population is illiterate, and 73% lack access to healthcare services. Mozambique has some of the highest maternal mortality rates in the world: 600 - 11000/100,000 live births. The same can be said for infant mortality rates, mortality under 5 years of age, and low birth weight. In Mozambique, the HIV infection rate is among the highest in the world; estimates for 2004 predicted a total of 1,500,000 people living with HIV/AIDS in Mozambique; 60% women and 40% men.

Objectives
The project is an integral part of the "Brescia for Mozambique" Program, born within the Peace Council of the Municipality of Brescia and the result of a coordination of Brescia-based NGOs and associations dealing with volunteering and international cooperation. The healthcare component of the project is the responsibility of Medicus Mundi Italia, supporting action in the Morrumbene Health District, Inhambane province, through support for maternal and child health programs and the prevention of vertical transmission of HIV.
The intervention consists essentially of the following aspects: a) provision of equipment for health centers in the Morrumbene district (a total of 9); b) nutritional support for malnourished and/or HIV+ children; c) training courses for healthcare workers on Maternal and Child Health, HIV/AIDS, malaria, and tuberculosis.

Activities
The first mission of the project took place in May 2009 with the objective of conducting a training course for nurses and midwives on vertical transmission of HIV infection. Three training courses were conducted, the last in collaboration with Dr. Fabio Uxa from the Burlo Garofalo Hospital in Trieste. During the missions, in addition to training activities, meetings were held with local health authorities to define the purchase of medical supplies and the payment of local staff responsible for visits to villages ("*Brigada Móvel* ") in the Morrumbene district.

Results
During the training courses, theoretical aspects of HIV infection and antiretroviral therapy during pregnancy were discussed, trying to adapt the topics to the level of training of the participants. 27 nurses, a local doctor, the health director of the district, and the nurse in charge of the maternal-child health program participated in the course, totaling 14 local healthcare workers. The overall evaluation of the course was excellent or good for all participants. A brief practical lesson on the preparation of slides for bacterioscopic examination was organized through Zielh-Nielsen staining; the lesson was conducted by the district laboratory technician.

Future Developments
With this project, it has been possible to initiate an action with an impact and repercussions on maternal and child health and the prevention of major infectious diseases in a region (the Morrumbene District) that shows significant deficiencies in access to basic healthcare and treatment for diseases such as AIDS and tuberculosis. As recognized by the District Health Directorate, which had requested the collaboration of Medicus Mundi Italia and will take responsibility for the continuity of the activities carried out, the project has supported the health improvement work carried out by the 9 health centers scattered throughout the territory and by the "Brigadas,"

with a capacity building perspective. The "Brescia for Mozambique" project has recently been approved by the Ministry of Foreign Affairs, and with the new financial resources, the continuity and expansion of the project's health activities are planned; this project is fully integrated into the Health Strategic Plan of the Provincial Health Department of Inhambane, in the national AIDS Strategic Plan, and in compliance with the general guidelines indicated by the national health Strategic Plan.

Name and surname: Antonio de Giovanni

Cycle: XXV– 2009/2010

Supervisor: Francesco Castelli

Title: Treatment adherence to short term therapy in a colombian indigenous and no indigenous population attending MSF mobile clinics

Project location: Norte de Santander, Colombia

Partner: Medecins sin Frontiers (MSF)

Context and problems

A number of rigorous reviews have found that, in developed countries, adherence treatment amongs patients suffering chronic diseases averages only 50%.The magnitude and impact of poor adherence in developing countries is assumed to be even higher given the paucity of health resources and inequities in access to health care. For example, in China, Gambia and Seychelles, only 43%,27% and 26% respectively of patients with hypertension adhere to their anti hypertensive medication regimen. Obtaining the medicine does not ensure its use. This represents a tremendous challenge to population health efforts where success is determined primarily by adherence to long term terapie. While in the literature there are a loto f studies aiming to assess the treatment adherence to long term terapie there are many few studies that aim to assess it in a short period treatment. To ascertain the true extent of adherence, more data on developing countries and important subgroups such as marginal populations are urgently requie. This study aims to assess the treatment adherence to short term terapie in a very difficult population like that living in a armed conflict area and served by mobile clinics. The study will be carried out in the area of Catatumbo in the Department of Norte de Santander, Colombia, a border area with Venezuela.

Objectives

To estimate the proportion of treatment adherence to short term terapies in an indigenous and no indigenous population attending MSFH mobile clinics in Colombia from July to september 2011.

Activities

Development of a study with the following features: a) Study: observational Prospective, b) Target Population: Patients > than 18 years of age attending MSF mobile clinics, c) Definition of adherence: For our study we define adherence as a 100% concurrency between clinical prescription and patient behaviour with a clinical prescription in terms of number of pills taken, dose interval and duration of the prescribed regimen.Our study focuses on the prescribed regimens with duration of 1 week or less, d) Inclusion Criteria: Patient will be eligible to partecipate in the study based on the following entry criteria: than 18 years old, Patient of the mobile clinic, acute diseases, no trivial diseases, patient living within half an hour walking from the mobile clinic, patient with a prescription with at least 1 oral antibiotic or anti parasitic drugs, regimen duration of 1 week or less, e) Exclusion Criteria. Patient will not be eligible to partecipate in the study based on the following exclusion criteria: < than 18 years old, patient referred to the mobile clinic by other medical doctor to receive drugs, patient living > than half an hour walking from the mobile clinic, patient without drug prescription, drug regimen >than 1 week, chronic diseases, trivial diseases other than oral route of administration.

Methods

When the patient meets the criteria of inclusion a formal consent will be requested to carry out an home visit at the end of the therapy to assess his/her health status. Treatment adherence will be measured using two indirect methods to assess adherence behaviour: manual pill count and self reported questionnaire using the Morisky-Green-Levine questionnaire as modified by Andres et al. In order not to alter the collection of data the patient will not be informed about the questionnaire and pill count.

Results

Up the date we have validated the questionnaire with a pilot group of patients. The study will start in July 2011.

Name and surname: Beatrice Autino

Cycle: XXV – 2009/2010

Tutor: Francesco Castelli

Title: Effectiveness and Feasibility of Antiretroviral Therapy in a Resource-Limited Setting

Project location: Ouagadougou, Nanoro (Burkina Faso)

Partners: Vice Provincia Camilliana, Medicus Mundi Italia, LVIA

Context and problems

HIV infection represents one of the main public health problems in Sub-Saharan Africa, particularly in Burkina Faso, one of the poorest countries in the world. According to estimates from the UNAIDS special program, approximately 110,000 people were HIV positive in Burkina Faso at the end of 2009, with a prevalence rate of 1.2% among adults aged 15 to 49. Despite awareness campaigns, which are increasingly common especially in the capital, heterosexual transmission remains the main cause of HIV infection, predominantly affecting women and children. With the introduction of antiretroviral therapy (ART), AIDS-related mortality in Burkina Faso has progressively decreased since 2000; however, the number of deaths caused by AIDS remains high (over 7,000 in 2009).

Objectives

The research is part of the ESTHER project La ricerca si inquadra nell'ambito del progetto ESTHER "*Lotta all'AIDS nel Settore 30 di Ouagadougou e nel Distretto rurale di Nanoro, Burkina Faso*". The research objectives are: a) Healthcare: outpatient care for patients with HIV/AIDS infection, b) Training: training of healthcare and para-healthcare personnel working at outpatient facilities, and c) Scientific: publication of results obtained nationally and internationally.

Activities

1. Healthcare: a) Outpatient clinical activities: management of patients with HIV/AIDS infection from a diagnostic and therapeutic perspective, b) Personalized *counseling* for family *planning* (FP): during each visit, sensitization to the use of contraception methods is provided, with referral of both consenting and non-consenting couples to FP sites, c) Quarterly drug orders from the CMLS (*Comité Ministériel de Lutte Contre le Sida)* and CAMEG (*Centrale d'Achet des Médicaments Essentiels Génériques*). In addition to ordering, management of pharmacy drug arrangements and monitoring of expiration dates are also carried out.
2. Training activities: Supervision of the work done by local staff and practical/logistical support.
3. Research activities: Collection and processing of clinical and laboratory data to evaluate the effectiveness and tolerability of antiretroviral therapy.

Results

The facilities where the ESTHER (*Ensemble pour une Solidarité Therapeutique en Réseau*) project operates are the structures of the Camillian Vice-Province. Medicus Mundi Italia (MMI) together with the University of Brescia has established a continuous collaboration with the Camillian structures; this relationship, which began in June 2003, continues to bear fruit both in terms of theoretical and practical support. Currently, 518 patients are enrolled in the CMSC active file, of which 435 are on antiretroviral therapy (5% of whom are on second-line therapy). 13% of patients have co-infection with hepatitis B virus and 1% with hepatitis C virus. The CMSC is a predominantly maternal and child health-oriented healthcare facility, as HIV screening for pregnant women and the prevention of mother-to-child transmission of HIV (PMTCT) are performed. From 2006 to 2010, 250 pregnant women tested positive for HIV; the 12-month follow-up of the 229 live-born babies only reports 2 HIV-positive babies (1%). 382 patients are enrolled in the CERBA active file, of which 349 are on antiretroviral therapy (8% of whom are on second-line therapy). 13.3% have co-infection with hepatitis B virus and 1.2% with hepatitis C virus.

Future Developments

The future objective is to develop operational research in the following areas:

• HIV/HBV co-infection.

• Evaluation of the effectiveness of the VIA/VILI (visual inspection with acetic acid/visual inspection with lugol's iodine solution) method used in PVS for cervical cancer screening.

• Comparison between VIA/VILI and Pap smear.

• Psychosocial support for HIV-positive patients and their families.

Name and surname: Federico Gobbi

Cycle: XXIV – 2008/2009

Tutor: Francesco Castelli

Title: Use of rapid diagnostic tests for malaria to improve the management of malaria cases in rural areas in Burkina Faso

Project location: Burkina Faso

Partners: Italian NGO (MIal) and UNIDEA Foundation

Context and problems

The research action takes place in Burkina Faso, Région sanitaire des Hauts-Bassins et des Cascades, in the provinces of Bobo-Dioulasso and Banfora. The research is closely linked to projects AN KA HERE SO 1 and 2, conducted in the same region by an Italian NGO (MIal) and the UNIDEA Foundation, in collaboration with the Ministry of Health of Burkina Faso and the Tropical Diseases Center of the "*Sacro Cuoret"* Hospital in Negrar (Verona). With project AN KA HERE SO 1, which ended in December 2007, the rapid diagnostic test for malaria (Paracheck) was introduced in the country, and the reading and interpretation of it by local nurses were verified. Project AN KA HERE SO 2, which began in January 2008 and will end in December 2010, includes three areas: health, literacy, and support for Income Generating Activities.

Objectives

To contribute to the sustainable improvement of the population's health conditions through the improvement of the quality of health services offered by CSPS (Centre de Santé et Promotion Sociale), increased financial accessibility to medical care in CSPS, and strengthening community participation in managing health issues in CSPS reference areas.

Activities

In Burkina Faso, ACTs have recently been introduced as first-line drugs in malaria therapy. Therefore, we decided to evaluate the safety, utility, and cost-effectiveness ratio of an RDT-based strategy compared to the current one characterized by presumptive treatment in cases of fever where diagnosis is not possible. We also intended to evaluate the adherence of health personnel to test results, especially negative ones. The study was conducted in 10 peripheral Health Centers (CSPS) at two different times, at the end of the dry season and at the end of the rainy season. The main objective of the study was to evaluate the persistence of fever on day 4, with secondary objectives being to assess the frequency of antimalarial and antibiotic administration.

Results

Patients were randomized into two arms, one group of patients benefited from RDTs before clinical decision-making, while the other group was evaluated traditionally. In the dry season, approximately 80% of patients with negative RDTs and in the rainy season, approximately 84% of patients with negative RDTs were treated with antimalarials. In the dry season, 186/852 febrile patients (22%) and 213/1382 afebrile patients (15%) had a P. falciparum infection. In the rainy season, these proportions were respectively 841/1317 (64%) and 623/1669 (37%). In the dry season, the sensitivity and specificity of RDT for malaria infection were 86% and 90%, respectively. In the rainy season, they were 94% and 78%, respectively. In the dry season, the sensitivity and specificity of RDT for malaria disease were 94% and 75%, respectively. The positive predictive value (PPV) was 9%, and the negative predictive value (NPV) was 99.8%. In the rainy season, the sensitivity and specificity for malaria disease were 97% and 55%, respectively. The PPV ranged from 38% in adults to 82% in children, while the NPV ranged from 84% in children to 99% in adults.

Future Developments

A study on the impact of clinical reasoning courses and ongoing training of nursing staff working in health centers is planned: the possible improvement of clinical management with the help of specific indicators will be evaluated.

Name and surname: Giuseppina De Iaco

Cycle: XXIV – 2008/2009

Tutor: Francesco Castelli

Title: Feasibility of a Tuberculosis Control Program in Tibetan Exile Communities in India

Project location: Dharamsala -India

Partners: Tibetan Delek Hospital (DH)/AISPO – Associazione italiana per la solidarietà tra i popoli

Context and problems

Tuberculosis is the fourth leading cause of death among members of the Tibetan community in exile in India, with approximately 550-600 new cases per 100,000. Unlike other developing countries, HIV does not seem to be the driving force of this epidemic. Instead, the causes may be related to the lack of health education and standardization of guidelines for diagnosing and treating the disease. A proper estimation of this problem can be obtained through surveillance. Therefore, surveillance represents a priority to identify the real dimensions of the problem, its nature, and at the same time suggest correct solutions.

Objectives

The aim is to integrate the project into the health development strategies of the Health Department, align the project with the WHO strategies for tuberculosis control, and maximize the use of local resources by providing essential technical assistance for the project's successful operation. Italian staff on short and long missions will work with local managers of the Tuberculosis Control Program to strengthen their professional capacities.

Activities

In the first six months, weekly meetings were organized with nursing, medical, and administrative staff to develop a TB management manual. On-site training sessions and subsequent supervision in nearby settlements were conducted to reinforce the basic concepts of the WHO's Directly Observed Treatment Strategy (DOT). At the same time, diagnostic equipment was purchased, and planning, organization, and financing were undertaken for the restructuring of the isolation ward to improve the quality of life for patients and, above all, to contain the risk of nosocomial transmission of infection, especially of resistant strains. In March 2009, a feasibility assessment mission for drug resistance surveillance was conducted.

Results

The ward was officially inaugurated in March 2010 on World TB Day. Patient enrollment began in April 2010. The most relevant epidemiological data are the young age (55% of patients < 24 years) and the frequent history of contact with a tuberculosis case. Twelve cases of MDR-TB and one case of XDR-TB are described out of 64 strains identified as MTB complex with antibiogram, accounting for approximately 20% of cases. In six cases, patients had newly identified TB, while in seven cases, patients had a history of previous TB diagnosis. Due to this data and to reduce waiting times and gain useful time for patient clinical management, a decision was made to purchase a new technology in April 2010 that allows for rapid molecular testing for MDR strains. The GeneXpert procedure can provide susceptibility or resistance results to rifampicin within 24-48 hours by directly analyzing the patient's sputum sample at the treatment center. Training was required to start using this technology. One limitation was the high cost of reagents. At present, 17 cases of rifampicin-resistant TB have been identified using this method. An "expert" committee has been formed, allowing for immediate discussion of complicated cases even in the most remote areas of India via a mailing list.

Future Developments

Complete patient enrollment from the three largest Tibetan TB hospitals in the DRS protocol, evaluate and disseminate the results of the surveillance investigation, assess the feasibility and sustainability of using a new molecular technology for rapid detection of drug-resistant tuberculosis cases, and identify and implement effective strategies for controlling and containing the transmission of resistant strains.

Name and surname: Fabio Buelli

Cycle: XXIII – 2007/2008

Tutor: Francesco Castelli

Title: Effectiveness of a regular implementation of the Mother to Child Transmission Plus (MTCT-plus) program in Burkina Faso, West-Africa

Project location: Burkina Faso

Partners: University of Brescia, Spedali Civili di Brescia, Medicus Mundi Italia, Centre Medicale Saint Camille di Ouagadougou

Context and problems

Since the early 1990s, many developing countries have implemented health strategies to reduce mother-to-child transmission of HIV (PMTCT - Prevention of Mother-to-Child Transmission). These strategies typically involve: (i) proper counseling for voluntary HIV testing during prenatal visits, (ii) administration of a single dose or short-course antiretroviral therapy to the mother and newborn, and (iii) exclusive artificial feeding or exclusive breastfeeding with early weaning. In a country like Burkina Faso, where HIV prevalence is estimated at around 1.8%, the PMTCT program was initiated at the end of 2002, with MTCT-plus programs introduced later, funded by the World Bank and Global Fund. Our MTCT-plus program operates within this context, with the main actor being the Saint Camille Medical Center in Ouagadougou, Burkina Faso, in partnership with the University of Brescia, Spedali Civili di Brescia, and the NGO Medicus Mundi Italia.

Objectives

To evaluate the actual implementation of the MTCT-plus program in Burkina Faso among family members of HIV-positive women recruited from the "active file" of the Saint Camille Medical Center in Ouagadougou (Burkina Faso). Specific objectives include: a) Applying international PMTCT protocols to reduce the number of children infected through vertical virus transmission; b) Determining HIV prevalence among family members of pregnant HIV-positive women attending our clinic; c) Providing psychological and potentially economic support to poorer families through direct links between the clinic and the "Aide moi a etre mere" association of Ouagadougou, an association of HIV-positive women.

Activities

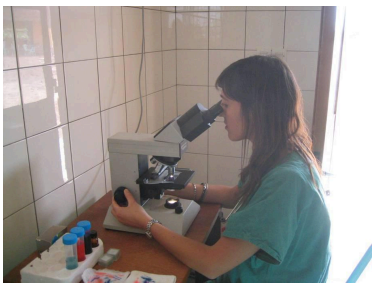
354 women were enrolled in the MTCT-plus program at the Saint Camille Medical Center. After counseling, 182 out of 344 living partners (52.9%) agreed to undergo HIV testing, with 115 out of 182 (63.2%) testing positive. Among partners who declined testing, 82 out of 162 (50.6%) were uninformed by the woman, while 29 out of 162 (17.9%) were informed but refused testing. HIV testing was conducted on 186 out of 348 (53.4%) children from pregnancies prior to enrollment, with an HIV prevalence of 10.2% (19/186), and on 231 out of 299 children born under PMTCT international protocols, with a prevalence of 4.3% (10/231). Only one out of 46 total co-wives in our sample was tested and found negative.

Results

The feasibility of the MTCT-plus program in West Africa is compromised by cultural barriers acting at different levels and requires new and innovative approaches to expand HIV testing in developing countries. Close collaboration with some associations of HIV-positive patients is attempting to overcome some of these barriers, particularly regarding gender issues. Monitoring partners and children remains very complex.

Future Developments

Potential developments of MTCT-plus programs in resource-limited countries are numerous: the compilation of a register of children and partners of women recruited at our center has begun to better define the family situation of each individual, including not only health and HIV test-related data but also the real situation of each child/partner. Increasing collaborations with local associations and/or organizations with the common goal (both medical and non-medical) of reducing the stigma associated with the disease is crucial, as it is the main cause of the low acceptability of testing among both partners and children of our patients.



Name and surname: Nuccia Saleri

Cycle: XXIII – 2007/2008

Tutor: Francesco Castelli

Title: Early Detection of Multidrug-Resistant Tuberculosis in High-Risk Patients for Guiding Early Management in Burkina Faso

Project location: Burkina Faso

Partners: Programma Nazionale Tubercolosi, Ministero della Sanità del Burkina Faso; Emerging Bacterial Pathogens Unit San Raffaele Scientific Institute

Context and problems

In Burkina Faso, tuberculosis is a significant health problem, leading to the establishment of a National Tuberculosis Control Program (PNT). Multi-drug resistant tuberculosis (MDR-TB) treatment is lengthy (minimum of 21 months, with at least 6 months of daily intramuscular injections) and associated with many serious side effects. The project has demonstrated the need to confirm resistance to anti-tuberculosis drugs before starting such a complex treatment. Since 2009, suspected MDR-TB patients can only commence treatment after diagnostic confirmation. To reduce diagnostic times, which would typically take 6-8 weeks using conventional methods, a new method based on detecting mutations directly on the *M. tuberculosis* gene is employed. This technique allows for the identification of rifampicin and isoniazid resistance with excellent sensitivity and specificity in a very short time (half a day).

Objectives

The study aims to improve the management and care of MDR-TB patients in Burkina Faso through early diagnosis of drug resistance and analyze the resistance profile of *M. tuberculosis* in high-risk MDR-TB patients. Specific objectives include: 1) Determine the frequency of MDR-TB cases in the following patient groups: failure cases of category II regimen (retreatment); TB cases and contacts of confirmed MDR-TB cases; category I regimen failure cases (new case treatment); relapse cases and cases restarting treatment after being declared lost and found; cases still sputum positive after three months of category I antituberculosis therapy, 2) Determine mutations related to resistance to fluoroquinolones and aminoglycosides, 3) Determine the proportion of MDR-TB strains with the same genotype, 4) Enhance technical capacities of the National Reference Laboratory in Ouagadougou, Burkina Faso.

Activities

Development of a research protocol, including early diagnosis of MDR-TB in high-risk patients and strengthening of the national reference laboratory. Training of involved healthcare personnel was conducted in October 2009, and patient recruitment began on November 1, 2009.

Results

82 high-risk MDR-TB patients were enrolled, with 9 patients having a negative direct examination of sputum at the national reference laboratory, and their samples were not sent to Italy. Sputum samples from 73 patients were sent to the San Raffaele Institute, which performed the necessary genotypic test for rifampicin and isoniazid resistance discrimination. On average, 7 days after sputum sample dispatch from Burkina Faso, the San Raffaele Institute provided genotypic test results. Diagnosed MDR-TB cases were immediately contacted by the two national pneumology services for hospitalization and treatment. Thanks to the study, 14 cases of MDR-TB were diagnosed and put on specific therapy. To emphasize the importance of early diagnosis, in routine PNT situations, patients in groups A and C would have waited 5 and 8 months, respectively, before starting specific MDR-TB therapy, with significant implications in terms of disease transmission.

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