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Dissemination Level		
PU	Public	**X**
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

TABLE OF CONTENTS

1. INTRODUCTION

1.1. Work package 2

The purpose of work package 2.2 is to establish a complete and cross-sectional diagnosis of the current situation in solid waste management at regional levels in the targeted countries. This will be the foundation stone upon which the consortium will propose appropriate technologies and organisational solutions as well as policy guidelines and recommendations in work packages 3 and 4 respectively.

1.2. Description of task 2.2

Task 2.2 of IWWA is concerned with the assembling of research and projects related to SWM which are being undertaken by consortium members. It also seeks to catalogue on-going SWM related projects that are being performed by organizations outside the consortium but within the targeted countries. Since IWWA encompasses all aspects of SWM, it is necessary that a common platform is created that highlights research activities taking place within the targeted countries, where useful lessons can be drawn from such projects. Relevant aspects of identified research works such as objectives, methods, results, expected impacts, and recommendations are captured in this report. Information collated would provide useful guidelines in the analysis and evaluation of prevailing conditions in the targeted countries, with regards to SWM. This task provides information on areas on SWM that are being focused by research institutions and thus reveal aspects that may have been glossed over or given little attention. The results of this task, together with those of Tasks 2.4 and 2.1.2, will assist in identifying relevant barriers and hindrances – technological, institutional, organizational, legal and political, socio-cultural and behavioural, among others – that are plaguing the delivery of ISWM practices in the targeted countries.

Moreover, this task will also create a platform where strong working partnerships would be achieve between IWWA consortium members and individual researchers from institutions outside the consortium who are making cross-cutting research within the entire spectrum of issues bothering on SWM. According to Task 2.2, identified institutions across the targeted countries would be invited to participate in the final conference in Accra where their perspectives on SWM would be given the necessary consideration. The synergy that would be created by bringing identified researchers into the fold of IWWA will enable comprehensive diagnosis of the real challenges affecting effective delivery of SWM in the targeted countries.

1.3. Objectives of task 2.2

The main objective of task 2.2 is to catalogue current research within and outside of the consortium members. This will form the basis of building a very strong network of researchers, experts and research institutions in waste management across the four targeted African countries and beyond. The purpose of this is to foster greater cooperation among identified research institutions across the targeted countries. This will lead to knowledge sharing and unnecessary duplication of research which will in tend save time and money. The specific objectives of task 2.2 are;

- Catalogue current research on solid waste management within the consortium members
- Catalogue current research on solid waste management outside of the consortium
- Provide a database of research institutions in the targeted countries
- Provide database of experts in the targeted countries who will be invited to join the consortium a and participate in future projects on SWM; and
- Get up to date information on solid waste management research carried out within the targeted countries

1.4. Methodology for mapping and evaluation of task current research

A template was developed for consortium members to provide information on research into solid waste management that they are currently involved. The template captured the objectives of the research, the main/key findings, the contact information of the researcher and any relevant literature associated with the study and key recommendations. Each consortium member filled and submitted the template together with a short write-up on the activities of the organisation. The report is divided into two sections. Section one deals with research within the consortium which was compiled by BCRC. Section two of this report which was compiled by KNUST deals with result of research outside of the consortium within the targeted countries. Other researches of interest concerning waste management within Africa were also captured.

The final report was compiled by KNUST with assistance from UAA, EMPA, ENDA, BCRC, TUB, ENDA, BIOAZUL, CEIA, ELRI, IAGU, and SLU.

2. CURRENT RESEARCH WITHIN CONSORTIUM

This section of the report maps out the various researches into waste management carried out by consortium members. A list of current research into solid waste management carried out by institution is presented below.

2.1. Centre for Environmental Impact Assessment (CEIA)

CEIA, a pro-poor scientific oriented research based non-governmental organisation, was established in 2006 to promote research projects, workshops and training activities for local communities in Ghana. CEIA works in areas that protect human health and the environment. The NGO conducts tests to independently monitor levels of toxic chemicals in industrial wastewaters in Ghana. It also advocates for environmentally sound mining practices in mining communities in Ghana.

Research and work activities of CEIA also revolve around the following themes: monitoring and risk assessment of hazardous chemicals, environmental application of advanced biotechnology, management of hazardous chemicals in industrial complexes, climate change, environmental risk assessment, waste management, and trans-boundary transport of air pollutants. CEIA has had working partnerships with international agencies such as the UN, OECD, Oxfam and Care International.

CEIA is involved in several tasks including, *inter alia,* task1.1, task 1.2, task 2.1, task 2.2, and task 3.4. In task 2.3, the identification of key players in SWM in the targeted countries, CEIA in collaboration with KNUST will provide information related to WEEE stakeholders. In task 5.1, CEIA and BCRC, will lead the assessment of the environmental effects of the proposed measures and action plans in previous work packages on regions characterized under work package 2. Finally, CEIA will lead task 6.1 which is concerned with the planning of stakeholder workshops in the targeted countries.

Project title (1)	The role recycling companies in dealing with the plastic mess in Ghana: A case study of Cyclus Recycling Company
Institution/department	Waste and Risk Assessment Department of CEIA
Objectives	To determine the challenges facing recycling companies in Ghana To determine how the companies obtain their raw materials To determine how primary/JHS and SHS students can play a role in dealing with the plastic mess through sorting of plastic wastes
Key findings	Companies face a lot of challenges which include financial, logistical, irregular power supply, limited knowledge of citizens on economic benefits to be derive from sorting of plastic wastes and selling them to companies Pupils/Students of primary/JHS/SHS were encouraged to be actively involved in segregation of plastic waste and selling them to Cyclus Through active involvement of pupils/students of primary/JHS/SHS in collection/sorting of plastic wastes and selling them to Cyclus, the concept of sorting/collection and collection of plastic wastes by residents adults in Cape Coast Metropolis is gaining ground.
Main recommendations	The concept of formation of waste/environmental clubs should be encouraged in our schools. The pupils/students should lead the educational campaign of waste sorting and selling by adults in Ghana
Researchers	Samuel Obiri (Lead Researcher), Frederick Armah, Achiaa Awuah Priscilla
Year	2010
Project title (2)	Using Maize Tassle to remove toxic chemicals from contaminated areas
Research type	Phyto-remediation of contaminated groundwater
Institution/department	Department of Biotechnology, CEIA
Objectives	To assess the performance of solid waste from plants such as maize tassle in removing toxic chemicals from contaminated groundwater in mining communities in Ghana
Key findings	On going
Main recommendations	On going
Researchers	Samuel Obiri (Lead Researcher), Frederick Armah, Achiaa Awuah Priscilla
Year	2010

2.2. Environmental Law Research Institution (ELRI)

ELRI is a non profit organization devoted to applied environmental research and policy analysis with the view to produce reports and policy recommendations on critical areas of environmental governance and protection in Nigeria and sub-Saharan Africa. ELRI proffers insightful and impartial analysis on environmental issues to policy makers, including government officials, environmental and business leaders, academics, administrative authorities, and the media. ELRI is currently on the Committee for the analysis and review of Lagos State Waste Management Act. The NGO is an affiliate of Environment and Health in Communities of Africans (ENHICA) International Foundation Inc. USA, and is on the accredited list of the World Bank and UNEP Civil Society Forum; ELRI is also listed on the Green Pages of the global directory for environmental technology (www.eco-web.com).

ELRI is involved in IWWA Project and documentation of other waste management materials in collaboration with Dr. Nlerum of the Nigerian Institute of Advanced Legal Studies (NIALS) located in the University of Lagos. ELRI is also involved in a similar collaboration with Professor Sridhar of the Department of Medicine, Niger-Delta University.

In IWWA, ELRI will lead and coordinate activities under work package 4 and participate in developing a proposal of policy guidelines as well as a set of recommendations for National and Regional Action Plans in each target country. ELRI will organize a capacity building workshop in Nigeria. Moreover they will write, jointly with ICANDO, an article and give a specific seminar during the Final Conference regarding policy guidelines and recommendations.

Project title (1)	Strategies for Household Waste Management in Nigeria: Legal Perspectives. (Post Doctoral)
Research type	A pilot scale project on strategies for the management of household waste in Nigeria
Institution/department	Nigerian Institute of Advanced Legal Studies (NIALS)
Objectives	Using 3 local governments as a case study, the project outcome will provide a guide for recommendations on policy formulations.
Researchers	Dr. Nlerum Francisca
Supervisor	Professor Olanrewaju Fagbohun
Year	2009 continuing

2.3. Bioazul S.L. (BIOAZUL)

BIOAZUL Company is a developer, promoter and facilitator of R&D projects in innovative environmental products. The product line of BIOAZUL includes organic waste treatment, soil remediation, complete SBR and MBR systems for wastewater treatment, and water reuse especially in remote locations or for specific wastewater compositions. BIOAZUL has an extensive experience in the preparation, management and participation in R&D projects in the fields of renewable energy and energy efficiency (especially concerning biomass), solid wastes and wastewater management, and environmentally-sound agriculture. BIOAZUL is currently working in the development and optimisation of biotechnological products and systems devoted to wastewater treatment and reuse, as well as in the preparation, development and management of projects within the VI and VII Framework Programmes of the European Commission.

BIOAZUL acts as administrative coordinator in the ongoing EU network on ecological wastewater treatment in West Africa (NETSSAF). In addition, BIOAZUL is the administrative coordinator of the ongoing initiative ISSOWAMA, a FP7 EU project which aims at the implementation of Integrated Solid Waste Management assessment methods in Asia. Using its knowledge and network from several international projects and wide international market experience in the West African Region, BIOAZUL has valuable local experience and partner networks in the target countries.

BIOAZUL is the administrative project coordinator of IWWA. The company is expected to bring its experience in technical treatment systems of specific organic waste in the development work in WP3, selecting best practices from Europe and non OECD countries, analyzing requirements for the implementation of ISWM systems in the target countries, and developing a guide for selection of adapted ISWM systems. BIOAZUL will develop and distribute posters and leaflets as mass dissemination material under work package 6 in order to disseminate the project results.

Project title (1)	Integrated sustainable solid waste management in Asia (ISSOWAMA)
Research type	Coordination Action (FP7)
Institution/department	Environment
Objectives	Specific strategic objectives of the project: To bring together relevant Asian and European stakeholders on solid waste management in order to establish a permanent cooperation strategy among them. To Promote Integrated Sustainable Waste Management in Asian developing countries, thus improving urban health and life quality and promoting their economy. To Consider Life Cycle Thinking to implement Sustainable Waste Management, thus decoupling economic growth from environmental damage in fast growing countries. To improve know-how and best management practices to relevant Asian stakeholders (municipalities and industries) on appropriate and cost-effective solid waste treatment and on waste minimization procedures. To identify existing and potential socio-economic barriers for the implementation of the new proposed technologies and to propose the best socio-economic strategies for implementing

	them. To disseminate the results obtained, raising awareness on the need to improve solid waste management in Asia. To more closely link the manufacturer and the waste manager in an optimisation of the overall system of energy, materials and waste flow. To create stronger links between waste management operations and the manufacturing and marketing phases of a product and how the organisations concerned with waste management can be more closely linked with both industry and consumers. Scientific and technological objectives of the project: To coordinate current research efforts in solid waste management in Asia, establishing a long term cooperation strategy. To analyse the main constraints for implementing new concepts on municipal and industrial solid waste management (from waste collection to treatment) in Asia, compiling data on waste generation and treatment in Asian developing countries and identifying also common and urgent problems throughout the continent. To find the most suitable and feasible solutions through the study of the most appropriate adapted technologies on solid waste management for each specific problem/case study in Asia. To develop a number of alternative integrated solid waste management systems in consultation with local Government and all stakeholders implied.
Key findings	The main objective of ISSOWAMA is to develop a performance assessment system for alternative waste management scenarios, which will consist of a set of qualitative sustainability criteria along with quantitative impact indicators enabling assessment of waste management strategies. The three sustainability aspects to be considered are environmental, economic and social aspects. Targeted end-users are municipalities, research institutions and end users. These results will be verified in different Asian cities.
Main recommendations	Promotion of international cooperation between research organisations, universities, and social and governmental stakeholders in a European and Asian context (local waste processors, local municipalities and policy makers, local NGOs representatives, etc).
Researchers	Mrs. Pilar Zapata
Year	2009- 2011
Project title (2)	Innovative Recycling technology for reusing olive mills washing water in Mediterranean Countries by microalgae (ALAGATEC)
Research type	Research for the benefit of SMEs (FP7)
Institution/department	Environment
Objectives	Overall Objectives:

	To provide an economic and feasible technical solution for reducing the use of drinkable water in the olives washing process, improving the management of drinkable water. To diminish the overall effluent of polluted water produced in olive oil mills, reducing the wastewater management costs and the environmental impact of wastes. To increase the competitiveness of the European olive oil industry through a cost-effective waste treatment and an improved water management. Scientific and technological objectives: To establish a cost-effective wastewater treatment and drinkable water recycling system for olives washing water. To build a prototype of a photo bioreactor using microalgae, adapting a patented technology to the specific needs of the treatment of the olive oil washing wastewater. To collect information about the main requirements for the system to be installed in the end-user industry, analysing the overall situation of producers in different EU countries (i.e. production amount and duration, WW). Socio-economic objectives: To reduce production costs in the olive oil sector through recycling and reutilisation of water. To answer to the current need of increasing the sustainability of European agricultural sectors by implementing a solution that will enhance the current water and wastewater management systems. To enable the olive oil producers in Europe keep its leadership in the olive oil market, with non-European countries entering the market. To increase employment in the sector by capacity building in state-of-the-art technologies and creation of new jobs in the design and construction of the proposed systems.
Key findings	To achieve the project objectives, ALGATEC will create a procedure for the treatment and reuse of washing water from the olive cleaning process. The ALGATEC process will include the pre-treatment of the washing water (preliminary filtration with a laminar settlement tank), the main treatment with a photo bioreactor using microalgae and the post-photo bioreactor treatment based on membrane filtration.
Main recommendations	ALGATEC is a Research for SME project included in the Seventh R+D Framework Programme of the European Union. Its objective is to propose a cost-efficient system for the on-site treatment and reuse of washing water generated in small olive oil mills, with high pollutant content, by means of an affordable and compact photo bioreactor using microalgae, capable to recover and recycle the majority of the drinkable water used in the process of olives washing. Furthermore, the problem of the disposal of wastewater from olive oil mills will be reduced because the

	reutilisation of the washing water will diminish the overall volume of wastewater, with both economical and environmental benefits. The current methods of wastewater disposal increase the overall production costs, and additionally they are also environmentally unacceptable and extremely inefficient in terms of water use. Thus, the proposed project will enable all participating SMEs to improve their competitive position opening a market of about 12,000 olive oil producers only in Europe.
Researchers	Antonia Lorenzo Lopez
Year	2009 – 2011
Project title (3)	Development of an innovative Sanitation and Wastewater Treatment system for remote located tourist facilities (SANBOX)
Research type	Research for the benefit of SMEs
Institution/department	Environment
Objectives	Scientific and technological objectives: Develop the technical research base for construction for a new aerobic prototype dewatering/decomposition reactor for concentrated black water with a capacity of at least 15 pe. Design a reactor for aerobic decomposition to achieve a hygienized compost product meeting the WHO standards for reuse in agriculture. Development of a new compact fixed-film grey water treatment unit with less than 2 m^3 space requirement for 15 pe, that reaches swimming water quality according 2006/7/EC and can be driven by solar energy. Development of two alternatives for black water liquid fraction post treatment: Solar-based evapotranspiration system with goal of zero effluent, and compact technical treatment system with less than 0.5 KWh/pe/day external energy consumption and swimming water quality effluent according 2006/7/EC for target markets with critical solar radiation in winter season. To build and integrate the different prototype modules into one compact treatment unit – Sanbox – not exceeding 10 m^2 base area and treating the load from at least 15pe reaching the target treatment performance. To assemble and test Sanbox modification for the Scandinavian target market on a target price of 30.000-40.000 € and an external energy requirement of less than 0.5 KWh/pe/day. To assemble and test Sanbox modification for the target market in the Alps on a target price of 30.000-40.000 € and without need for external energy supply. To assemble and test Sanbox modification for Mediterranean target market on a target price of 25.000-30.000 € and without need for external energy supply. Social and environmental objectives: To open up new markets for the participating SMEs. To minimize the impact on landscape and water bodies which is important for local tourism.

	To provide the end-users and tourists with improved sanitation facilities. To provide opportunities for demonstration and training of the environmental awareness of the general public. To reduce negative environmental and health impacts arising from insufficient wastewater treatment in remote and unsewered areas and vulnerable alpine, carst and coastal zones. • To efficiently use scarce water resources. • To lower the transport and energy use needed for operation and maintenance of sanitary facilities, especially in remote areas.
Key findings	The new system (**Sanbox**) to be developed during the project includes innovative modules for black water and grey water treatment and an evapotranspiration system. In the final stage of the project three specific **Sanbox** prototypes tailored for three different target markets will be assembled and tested. The prototype testing involves two end-users the Swiss Alpine Club and the Soline at Piran Saline Natural Park in Slovenia. The Swiss Alpine Club is one of the main operators of high mountain lodges in the Alps and aims to reduce potential emissions into the highly vulnerable alpine environment. Soline is a company with the goal to start a sustainable tourism business around the Piran saline flats on the Mediterranean coast in Slovenia. This project provides the end-users an expected “zero-emission” solution regarding black water effluents and swimming water quality regarding grey water effluents, while the SMEs receive important research base as well as and user feedback for the development of the commercial product and dissemination of the results. The goal is to demonstrate that near “zero emission” of wastewater constituents is no longer science fiction.
Main recommendations	**Sanbox** is a Research for the benefit of SME project funded by the Seventh R&D Framework Programme of the European Commission in which a group of 5 European SMEs, all active in the market for decentralised wastewater systems, intends to develop an innovative, compact wastewater treatment system to serve the growing market for upgraded sanitation facilities for remote located tourist facilities such as mountain lodges or buildings in sensitive coastal and karst areas. The increasing interest of potential customers as Alpine Clubs, agro-tourism or hotels arise from more demanding regulations, the tourists’ increasing comfort expectations and the enterprises own interest in protecting and keeping the local environment attractive for tourists. To meet this demand the SMEs came up with a vision of a compact, low energy consuming, source separating and high performance wastewater treatment and handling system that is adapted to the specific end-user requirements.
Researchers	Rafael Casielles Restoy
Year	2009 – 2011

Project title (4)	Waste reduction and process optimisation in the European meat and dairy industry (Waste-Red)
Research type	Eco-innovation research project
Institution/department	Environment
Objectives	The general objectives of the project are: Introducing LODO red as an eco-efficient product into the meat and dairy sector. Reducing the waste production and ecological footprint in these industries and raise environmental awareness. Use cost saving potentials and increase competiveness of the European meat and dairy sector (mainly SME).
Key findings	Thanks to this Project, the proposed sectors will be able to improve their competitiveness due to the reduction of costs derived from the treatment and management of these wastes as well as to the reduction of their contribution to environmental pollution.
Main recommendations	WASTE red is a project funded by the EACI through the CIP ECO-INNOVATION programme under the area of waste reduction in the food sector. In particular, the meat and dairy industries are two of the main food sectors in the European Union generating a big amount of wastes. These industries consume a huge water quantity that must be treated before its disposal to the sewage system. In the wastewater treatment process, it is produced a big amount of sewage sludge, that must be treated before its use or elimination and constitutes approximately the 50% of the wastewater treatment plants costs. This Project aims to reduce the waste produced in three object countries, Poland, Germany and Spain, to be later extended to the rest of the European Union countries. This reduction of wastes will be achieved thanks to the utilisation of an additive called LODOred^{-100k}, responsible for sewage sludge reduction in wastewater treatment plants of different countries from the European Union. LODOred^{-100k} is a very efficient and highly complex agent combining vitamins, enzyme stabilisers, additives and auxiliary substances. It leads to a polymeric encapsulation of bacteria conglomerations in the aerated tank and supports the mass transfer within the flocks. It is totally biodegradable and according to the last Community legislation, the use of its ingredients is allowed in the food sector.
Researchers	Jose Luis Bribian
Year	2009-2011
Project title (5)	Promotion of Short Rotation Coppice for District Heating Systems in Eastern Europe (BIO-HEAT)
Research type	Intelligent Energy Europe research project
Institution/department	Environment
Objectives	BIO-HEAT specific objectives are:

	To widespread the existing knowledge, experience and know-how on SRCs application as a source of energy for DH, to further disseminate the results of related projects, reaching new targeted groups in Eastern Europe. To promote SRC biomass production by raising awareness and transferring specific information for key-members of the energy sector. To create local agricultural value on basis of renewable and CO_2 neutral sources of energy throughout Eastern Europe. To provide access to valuable information of SRCs as a CO2 neutral biomass source for CHP plants to DH operators and to related stakeholders and decision makers – especially from Eastern European countries - in order to raise awareness and to transfer know-how amongst Eastern European farmers about the potential of biomass as a high efficient, low-cost and sustainable source of combustible and the opportunities their use offers. To connect all relevant stakeholders through a web based platform to ensure a long-term information flow and to initiate local initiatives and implementation for SRC in combination with DH, as one sustainable outcome even for external parties. To implement a comprehensive dissemination strategy focused on the transfer of best practices and networking of professionals, decision makers and national support scheme managers. This will run together with a training plan, which will be the guideline and instrument for transferring essential knowledge to the most important groups of key actors - as given in the overview above - in the promotion of SRCs as an energy source for DH. To transfer the practical oriented information derived from the previous projects, to end users especially landowners, power plant engineers and municipal energy suppliers. This strategy will initiate or strengthen national plans and will increase the number of initiatives regarding the use of SRCs. Tackling technical and non-technical barriers that hinder implementation of SRCs, or that the end user could encounter. This will be achieved through the organisation of practical workshops reaching more than 3.200 key-members of the Industrial Association Groups participating. During these workshops, DH professionals, policy makers, authorities and other relevant stakeholders will be informed in detail about the SRCs use benefits, and they will be encouraged to support schemes and legal frameworks that affect SRC. Speakers will be, among others, technological practitioners, technology providers, farmers who already produce SRC, and DH operators. Statement of future dissemination activities and promotion plans. A common program about attendance to future conferences, trade fairs, seminars, etc. will be developed during and after the project timeframe in order to maintain and strengthen the information channels created within and outside the project. Opening up new markets for renewable energy sources, as well

	as to assure continuous energy supply from RES
Key findings	BIO-HEAT project will build on those successful projects mainly by using results and avoid duplication of the work already performed by some of the BIO-HEAT partners. In projects such as BIOPROS, already economic, ecological and technical feasibility studies of Short Rotation Plantations for different local conditions and market requirements were performed and this know-how was transferred to the SME members (farmers, biomass processors, engineers, decisions makers) for the promotion of this way of biomass production. BIO-HEAT partners participating in previous projects have learned how to design effective dissemination activities and to develop adequate training material for the real implementation of these plantations, such as the SRC guidelines for farmers, authorities and end users.
Main recommendations	BIO-HEAT is a R&D project under Intelligent Energy Programme of the European Commission. BIO-HEAT comes up as a continuation of European and national research and development projects, such as the FP6 BIOPROS, NETBIOCOF, LADAS, WAFLA, WACOSYS, INAWAB, dealing with biomass-production for combustion. Restricted partnerships, and work programmes and resources of these successful projects did not cover some high-potential regions in Eastern Europe. Based on these successful previous experiences, and taking into account that its most important point would be to inform, motivate & convince the key-stakeholders of the whole value chain. BIO-HEAT represents the necessary dissemination and exploitation steps, aiming at implementing SRCs application as an energy source for DH in Eastern European countries due to their energy needs and their potential as SRCs producers. Furthermore SRC systems can create economic, social and environmental friendly value chains especially in rural and/or agricultural affected areas.
Researchers	Pilar Zapata
Year	2009-2011
Project title (6)	Network for the development of Sustainable approaches for Large Scale Implementation of Sanitation in Africa (NETSSAF)
Research type	Coordination Action (FP6)
Institution/department	Environment
Objectives	Specific strategic objectives of the NETSSAF Co-ordination Action: To prepare the technical, social and policy bases for the future large-scale implementation of low cost technologies for sustainable sanitation in West Africa. To encourage the establishment of permanent communication links between research centres, rural developing associations, regional networks, authorities and other stakeholders in Africa, focusing in the western region, promoting the know-how exchange and expertise in relation to innovative sanitation

	approaches for large-scale implementation. To co-ordinate current research and development activities in Africa, focusing in the western region, in order to promote cooperation and avoid overlapping and duplication of efforts, taking into account traditional knowledge and innovation technologies. To define, initiate and guide future R&D activities on West African level by mapping current research and forming research clusters in order to fulfil the scientific and technological needs for the further large-scale implementation of innovative and feasible sanitation concepts. To identify a variety of innovative, adaptable and replicable approaches to sustainable sanitation in Africa, aiming at integrating appropriate low cost technologies in the context of community based management. To disseminate the results, through a Sustainable Sanitation Extension Programme, designed specially to reach the local communities and to build capacity of authorities for future implementation and dissemination, developing institutional mechanisms for deployment of extension strategy. Scientific and technological objectives: To evaluate and classify in a multidisciplinary approach a group of existent rural and peri-urban settlements with no access to improved sanitation in West Africa, selecting a set of typical cases. To review and discuss different sanitation technologies (conventional and innovative), by using experiences of implementation in West Africa and other developing regions. To develop adequate strategies for large-scale implementation of low-cost sanitation technologies in peri-urban and rural areas, focusing on their relevant governance, institutional frameworks and socio-economical aspects in the African context. To identify suitable sanitation technologies for each typical case, according to the characteristics and needs identified regarding technical, social, economical, environmental, institutional and legal aspects. To identify the technical requirements of each technology selected for large-scale implementation, regarding sourcing, logistics, installation, operation and maintenance. To identify the non-technical requirements of each technology selected for large-scale implementation, regarding human, financial, economical, environmental, legal and institutional aspects. To identify, map and contact the existent regional suppliers of the technological requirements of each sanitation technology selected, in order to prepare a West African database of Sanitation Supply.

	To identify and map the current sanitation implementation activities and their actors in West African, in order to prepare a West African database of potential technology transfer associations and groups, which will participate in a future massive implementation. To propose and design an Adapted Sustainable Sanitation Management System, to support decision makers and beneficiaries in identifying feasible sanitation alternatives for large-scale implementation by using low-cost technologies adapted to the different physical and socio-economic conditions prevailing in West Africa.
Key findings	**NETSSAF** project is a coordination action included in the Sixth R+D Framework Programme of the European Union which aimed to congregate the most relevant stakeholders in the field of sustainable sanitation in the Sub-Saharan African and European frame, promoting international cooperation between research organizations, associations, universities and social and governmental stakeholders from both regions. It integrated in a multidisciplinary approach the local and international initiatives in the field of sustainable sanitation in order to bring together the existing community needs and on-going sanitation developments, pointing out the needed research and technology efforts to propose feasible mechanisms to enhance the massive implementation of sustainable sanitation in the West Africa region. The consortium identified a variety of innovative, adaptable and replicable approaches to sustainable sanitation, aiming at integrating appropriate low cost technologies in the context of community-based management. NETSSAF contributed by identifying typical peri-urban and rural settlements in West Africa and the most important characteristics regarding technical, social, governmental, legal and environmental issues in order to design feasible sanitation options for each case. NETSSAF consortium brought together innovative approaches of sanitation and their current pilot applications in Africa and other developing regions, assessing their suitability, thus promoting the application of best practices and adaptable technologies. NETSSAF coordination action, not only recommended a set of low-cost technologies that better fit the sanitation needs of peri-urban and rural areas in Africa, but also provided the technological and logistics basis for its short-term implementation, by the creating a West African data base of Sanitation Suppliers which could be contacted by the end users when planning a sanitation project. The final outcome was the development of a Participative Multi-stakeholder Sanitation Management Support Tool aimed for the end-users to be able to apply large scale sanitation concepts and technologies adapted to the different conditions prevailing in Africa.
Main recommendations	Sanitation includes solid waste disposal, wastewater disposal,

	wastewater reuse, human excreta disposal and drainage of rainwater. However, NETSSAF focused on the management of municipal wastewater and human excreta in peri-urban and rural areas by means of improved and sustainable sanitation. Improved sanitation refers to excreta disposal facilities that can effectively prevent human, animal, and insect contact with excreta, ranging from simple but protected pit latrines to flush toilets with a sewage connection. To be considered effective, facilities must be correctly constructed and properly maintained. Sustainable sanitation encompasses in general the following criteria: Disease prevention: the sanitation system must be capable of destroying or isolating faecal pathogens. Environmental protection: it must prevent pollution and conserve valuable water resources. Affordability: the sanitation system must be accessible to the world's poorest people. Acceptability: it must be aesthetically inoffensive and consistent with cultural and social values. Simplicity: the sanitation system must be robust enough to be easily maintained. The full range of technical options for providing adequate basic sanitation is still not widely understood. In particular, there is little appreciation of the long-term financial implications of operating the various sanitation systems. As a result, communities and local governments are currently choosing technical options that, in the long term, are unaffordable and unsustainable. Complications arise from the wide range of options available and the differing environments in which they must be implemented. Experience shows that it is important to allow local solutions to be developed. The options include the ventilated improved pit toilet in all its variations, composting toilets and on-site wet systems such as septic tanks, and full water borne systems.
Researchers	Antonia Lorenzo Pilar Zapata Rafael Casielles
Year	2006-2009
Project title (7)	New energy efficient approach to the operation of Membrane Bioreactors for Decentralised Wastewater Treatment (PURATREAT)
Research type	Specific Targeted Research Project for international Cooperation with Mediterranean Countries (INCO-MED)
Institution/department	Environment
Objectives	Main strategic objectives of the PURATREAT project: To open the way to the adoption of cost-effective decentralised wastewater treatment plants in the Mediterranean partner countries To assist in the preservation of water resources thus

	contributing to the sustainable development in the Mediterranean region. To foster membrane technology for wastewater treatment on both sides of the Mediterranean. To initiate an international forum for MBR researchers from the EU and non-European Mediterranean countries. Main technical objectives: To compare the performance of MBR bioreactor's working under conventional operating conditions with the performance achieved under conditions specially adapted to the requirements of MENA countries. To compare the performance the most advanced membrane technologies available in the market working in different operating conditions. To study the performance, energy consumption and maintenance requirements of MBRs working at low Solids Retention Times as a possible operating procedure for the application of these system in peri-urban areas of MENA countries. to study the characteristics of the microbial community present in the reactor for the different at the experimental conditions studied to propose the most suitable technology for the application of decentralised MBR wastewater systems and its optimum operating conditions to study the feasibility of decentralised wastewater treatment plants based on MBR technologies in the MPC countries
Key findings	PURATREAT aimed to develop a method for decentralized wastewater treatment that allows the re-use of water with minimal operational and maintenance costs. This project studied the most suitable MBR wastewater technology to be applied to peri-urban areas of the southern Mediterranean and Middle East countries. Laboratory test with membrane bioreactor were carried out in order to study and compare the performance of the three leading membrane technologies operated in a way which produced low maintenance and operation costs. Therefore, this project initiated a new approach to operating MBR systems adapted to the financial constraints affecting Southern Mediterranean and Middle East peri-urban or rural communities. The consortium studied the performance and feasibility of the bioreactor working at minimum aeration rate and short solids retention time, operating conditions that allowed the adoption of this kind of technology as a cost-effective decentralised wastewater treatment solution. In addition, the construction and running costs of a potential full scale decentralised wastewater treatment plant was contrasted with the investment capacity available to several Mediterranean peri-urban areas in North

	Africa and the Middle East, where expenditure in public services is a critical factor.
Main recommendations	The traditional solution for decentralized wastewater treatment in the Mediterranean region was just to use cesspits or septic systems. This system is very simple but it is only acceptable for very small groups of houses and under very well defined conditions on the receiving soil (determined soil permeability, certain depth to the water table, etc). This system can lead to groundwater contamination, foul odor and it does not allow for safe water re-use to any extent. A more efficient system is activated sludge plants and SBR (Sequencing Batch Reactor, a modification of the latest one). This process is based on the aerobic digestion of wastewater with flocculating biological growth, followed by separation of treated wastewater from this growth. These systems are fairly efficient in general, although they produce bulky sludge, provide insufficient disinfection for water reuse and have high-energy consumption. The most efficient treatment in terms of energy consumption and water purification is the membrane bioreactor's (MBR), which comprises an activated sludge tank in which membrane filtration modules (either micro filtration or ultra filtration) are submerged. It has been proved that this system is the only one that can guarantee a germ-free effluent which can be reused with total safety for technical purposes (such as toilet flushing) and which at the same time does not produce toxic compounds (such as chlorination). In general, the problem with all existing membrane bioreactors is related to the characteristics of the membranes and to the way the bioreactor are operated. It has been proved that these components display low flow rates and are prone to clogging by accumulation of organic material, requiring continuous air pumping to clean the membranes, which means considerable energy consumption. In the long term, fouling in the membranes boundary zone has been identified as another significant disadvantage of this treatment method, what implies the use of chemicals to clean the membrane or even the replacement of these ones. Moreover, high mechanical stress caused by aeration can break off the capillaries. All these problems lead to increased maintenance needs, high energy consumption, frequent membrane replacement and sometimes increased organic loads and germs in the effluent (when the membranes rip off). In this project three different types of state-of-art sub-merged hollow-fiber membrane modules were tested and compared under different operating conditions.
Researchers	Antonia Lorenzo Jose Luis Bribian
Year	2006-2008
Project title (8)	**AGROBIOGAS**

Research type	Collective Research (FP6)
Institution/department	Environment
Objectives	To increase the efficiency of Anaerobic Digestion (AD) with agricultural waste in co-digestion with other organic residues by developing: To gather the scattered information about biogas local projects and make it accessible to farmers and farmers associations, ensuring a successful performance of current and future AD plants. To reduce the uncontrolled disposal of AD sludge by the development of recommendations for the use of it as bio-fertiliser (the bio-fertiliser certification system will be accomplished by the end of month 8) To train the IAGs in utilisation of the Helpdesk components, the co-fermentation Substrate database and in applying the bio-fertiliser recommendations. V. To disseminate the generated knowledge
Key findings	Laboratory/pilot scale experiments on co- in order to support the results obtained by simulation. An European co-fermentation substrate database A specific AD Simulation Toolkit in order to predict the most convenient mixtures of co-substrates for decentralised agricultural biogas plants taking into account the wide variety of farmers and conditions in Europe. To perform large scale experiments to evaluate and optimise the AD Simulation Toolkit Developing an European Agricultural Helpdesk Network of advice for decentralised AD plants To develop an Investment Decision Tool based on the AD simulation toolkit to advise farmers interested in AD Specific training activities for IAGs, (seminars of discussion – combined with workshop, seminars of training for software use, workshops on full scale plants, etc) partners related with the agriculture development, related with the assessment, consulting and dissemination of new. Specific training activities for SMEs core groups (workshops on model full-scale AD plants with 10-15 participants, seminars, courses of management AD plants, environmental legislation courses, etc)of farmers and SME related with the provision of AD technologies and consulting were accomplished.
Main recommendations	There are still many challenges to be solved in order to make Anaerobic Digestion technology effective to treat agricultural waste and widely accessible to European farmers. Its distribution is still scattered in the EU and farmers, depending on their location, have different opportunities to apply this technology. It is necessary to clarify which are the best conditions, adapted to local situations to treat the targeted residues and make this information accessible to farmers though the IAGs which

	represent them. The possibility of co-digestion opens a door plenty of potential to farmers who could be able to treat their own waste together with other organic substrates. By these means, farmers will treat their own residues properly and at the same time, they could make a profit by treating and managing organic waste from other sources (waste disposal and management fees) and by selling and/or using its outputs: heat and electrical power together with a stabilised bio fertiliser. The aim of the proposing IAGs is to gather and gain knowledge about financial, legal and technical requirements to develop feasible agricultural AD treatments for different local conditions to further transfer it to their SME members. This will strengthen the competitiveness of AD treatment of agriculture waste against other treatments and will ensure the compliance with the European and national environmental legislation.
Researchers	Pilar Zapata
Year	2006-2009

2.4. Technische Universität Berlin (TUB)

The Research Center Microperipheric Technologies at the Technische Universität Berlin (TUB) is a worldwide recognised institution in microelectronics and electronics packaging. The group Sustainable Technologies works since the early 1990s on environmental topics related to electronics, such as energy efficiency, environmental assessments, Green IT and ecodesign concepts for small and medium sized enterprises. The Research Center with 35 researchers is closely linked to the Fraunhofer IZM (staff: 250). A cooperation treaty allows close cooperation, exchange of knowledge and human resources. At Fraunhofer IZM additional expertise in the field of ecodesign, energy efficiency and the EuP directive is at hand. Both the Research Center and Fraunhofer IZM have a strong background in electrical engineering and the staffs are trained to explain technological issues to non-technologists.

The department “Environmental and Reliability Engineering” comprises 12 senior experts with backgrounds in electrical engineering, environmental engineering, mechanical engineering, chemistry, economics, and social sciences. In 2000, 2004 and 2008, TU Berlin and Fraunhofer IZM jointly hosted the Electronics Goes Green conference, the world largest event on electronics and the environment. TUB was and is involved in more than 100 projects funded by the EU (FP6, FP7, CIP, IEE etc. etc.), being in charge of project management and coordination for many of them.

Project title (1)	ReUse
Research type	research network of the national organisations, technical experts and SMEs computer industry
Institution/department	TU-Berlin
Objectives	establish and expand the reuse of computers Built up networks of companies for repairing, maintaining and upgrading used equipment in two regions. The reuse project deals with technical, organisational and legal questions Identify obstacles in acceptance to find a way to overcome them. Make the reuse of computers attractive and to improve the whole service
Key findings	ReUse networks have been established in Hamburg and Berlin, now working on a self-financed basis.
Main recommendations	
Researchers	Karsten Schischke, Dr. Jutta Müller
Year	2001-2004
Project title (2)	GreenRoSe
Research type	Research for SME associations / TRTD and Innovation related activities
Institution/department	ABELIA (Norway), TU-Berlin, ITRI
Objectives	Maximise awareness of European electronics SMEs about removal of hazardous substances from electronics via each consortium IAG, through regional workshops, press articles and a set of training materials in regional languages. Research and advance the available knowledge base on environmental, technical and business issues associated with removal of hazardous substances from electronics, producing and distributing reports, papers and presentations. Develop real-world customised solutions for SMEs based on case studies carried out at all Core Group SMEs, ensuring that all will comply with RoHS Directive. Engage the SME community directly by creating a set of training materials for SMEs in regional languages, holding on-site training courses at Core Group SMEs and off-site training courses in each region represented in the consortium.
Key findings	Established ReUse networks in Hamburg and Berlin, now working on a self-financed basis.
Main recommendations	SMEs need a coordinated support to fulfil the legal requirements Regarding the limited resources of SMEs there is a need of accompanying research to close important knowledge gaps
Researchers	Karsten Schischke
Year	2004-2006
Project title (3)	ELFNET
Research type	research network of the national organisations, technical experts and industry bodies in micro-electronics

Institution/department	TU-Berlin
Objectives	Implement lead free electronics production processes in Europe Research on applicable lead free technologies. Cause existing technology is seriously lacking in integration, and there is no coherent knowledge-base. Set up a network of 40 key partners from across Europe. Based on a 3-dimensional structure with National Networks, Technical Experts and Industry Networks from each sector. provide vital technology information to each Member State
Key findings	Integrated a strong European wide network of experts on lead free issues In a broader sense a successful implementation of lead-free technology in the electronics industry.
Main recommendations	The introduction of the RoHS Directive in particular has massively increased the demand for ESCM, both in terms of the need to transfer data on hazardous substances and of the need to cost effectively source RoHS-compatible components. Within this new paradigm there is an urgent need to collaborate in achieving harmonisation on information exchange protocols and formats, to avoid a chaotic multiplicity of practices. Coherent collaboration in development and implementation of new technologies across European boundaries is the key to ensuring global competitiveness.
Researchers	Dr. Otmar Deubzer, Karl-Heinz Zuber
Year	2004-2006
Project title 4	ZeroWIN
Research type	Industrial networking and zero-waste entrepreneurship
Institution/department	Austrian Society for Systems Engineering and Automation, TU-Berlin
Objectives	Common vision on zero-waste entrepreneurship for industrial networks in the automotive, construction, electronics and photovoltaic industries Investigate individual producer responsibility Finding of new technological developments and waste prevention methodologies/strategies Development of an innovative production model for resource-use optimisation and waste prevention Monitoring and validation of the improvements by quantitative assessments
Key findings	Expected results within the project: Decrease of at least 30% of greenhouse gases emissions At least 70% of overall re-use and recycling of waste, A reduction of at least 75% of fresh water utilisation.
Main recommendations	Not yet available
Researchers	Dr. Andreas Middendorf, Max Marwede
Year	2009-2014

2.5. Swedish University of Agricultural Sciences (SLU)

The Swedish University of Agricultural Sciences promotes higher education and research in sustainable use and management of biological natural resources. SLU offers a number of educational programmes, including veterinary medicine, forestry, landscape architecture and engineering. More than 68 % of SLU's annual expenditure goes into research. SLU has over 3,500 employees, 3,800 undergraduate students and 700 postgraduate students. The Department of Energy and Technology has long experience of research and assessment projects concerning agricultural systems, including resources originating from agriculture, such as food and bio energy. One speciality is organic waste management systems, the effects of these systems on environment and their resource efficiency, function, robustness and acceptability. The department has, in cooperation with partners, developed the software assessment package ORWARE, which is based on LCA (Life Cycle Assessment) methodology. At the department there is experience from working in several projects in Africa, including ongoing projects in both East and West Africa, on sanitation, waste management and food chain logistics.

SLU will play key roles in task 2.5 and in work package 3. SLU's experience in organic waste management systems would be brought to bear in the enumeration of international best practices – technological, policy, behavioural, legal, and policy – in SWM in OECD and non-OECD countries than can be adopted in the targeted countries. SLU will also assist in the development of policy guidelines and recommendations for consideration in the targeted countries. Working with OEKO, SLU will write an article highlighting barriers to proper SWM in the targeted countries for publication in a reputed journal.

Project title	Assessing sustainability of sanitation options – Case study in Kumasi, Ghana
Research type	Post-doctoral research, incl 5 MSc projects
Institution/department	SLU, Department of Energy and Technology
Objectives	The project aims at an integrated sustainability assessment of sanitation in a city in West Africa. Specifically, the objective is to define and describe scenarios for future sanitation development in Kumasi, Ghana, and to assess their environmental performance. The project includes also economic investigations
Key findings	It should be possible to introduce source-separation at the household level as a component of efficient waste management systems with high recycling rates in urban centres in Africa, with some economic incentives to households. There is a potential to generate electricity through anaerobic digestion or incineration of waste. A local nutrient reuse approach did not appear applicable to dense, urban areas, since the production of fertilizers was much larger than the need. It seemed however, to be a feasible option in more spatial areas, where farms and back yard cultivation are more common. By changing from landfill to composting, greenhouse gas

	emission savings could be 19 000 – 21 000 tCO2e every year. This would generate secondary Certified Emission Reduction credits of approximately annual mean of 230 000 –250 000 Euros with November 2009 market prices.
Main recommendations	Waste management policies in Africa should target source separation as part of the efforts to increase recycling and ensure effective waste management.
Researchers	Cecilia Sundberg, Kristina Dahlman, Emma Wikner, Andreas Boström, Emmanuel Adjei Addo, Joseph Marfo, Victor Owusu, Moses Mensah, Pay Drechsel
Year	2007-2011

Project title (2)	Greenhouse gas, acidifying and eutrophying emissions from compost and composting
Research type	PhD research
Institution/department	SLU, Department of Energy and Technology
Objectives	Quantify GHG and Eutrophying emissions from composting in well controlled reactor environments Suggest process optimization for emissions reduction
Key findings	Not yet available
Main recommendations	Not yet available
Researchers	Evgheni Ermolaev, H. Jönsson, C.Sundberg, M. Pell
Year	2010-2012

Project title (3)	Environmental emissions from home composting
Research type	MSc and PhD
Institution/department	SLU, Department of Energy and Technology
Objectives	Quantify emission of ammonia, nitrous oxide and methane from home composting of food waste, through monthly measurements on 19 composts used in home gardens during one year
Key findings	Emissions of ammonia were low to very low Methane concentrations were in most cases lower than 0.3% of CO2 concentration Nitrous oxide concentrations were in most cases lower than 0.2 % of CO2 concentration There was a significant positive correlation between water content and methane emission
Main recommendations	Keep the moisture content moderate, do not let it become too high
Researchers	Björn Kempe, Alexander Johansson, Evgheni Ermolaev, Håkan Jönsson, Cecilia Sundberg, Mikael Pell
Year	2010-2011

Project title (3)	Waste Logistics in Kampala Uganda
Research type	PhD project
Institution/department	SLU, Department of Energy and Technology and Makerere

	University, Department of Civil Engineering
Objectives	Develop knowledge required to improve the waste logistics in Kampala, Uganda. This includes mapping and analysing waste flows and investigating logistic alternatives
Key findings	Not available yet
Main recommendations	Not available yet
Researchers	Joel Kinobe
Year	2010-2014

Project title (4)	Environmental systems analysis of household wastes treatment technologies in Kampala, Uganda.
Research type	PhD project
Institution/department	SLU, Department of Energy and Technology and Makerere University, Department of Agricultural Engineering
Objectives	Waste characterization and nutrient flows from domestic waste in Kampala. Comparison of main technologies for handling domestic wastes in Kampala, Uganda using life cycle assessment method. Environmental Systems Analysis of biogas systems in Uganda.
Key findings	Not available yet
Main recommendations	Not available yet
Researchers	2010-2014
Year	Allan John Komakech

Project title (5)	Waste Management in Somanya and Agormanya, Ghana
Research type	MSc project
Institution/department	SLU
Objectives	What are the perceptions of the local people on waste management in the towns of Agomany and Somanya? - Does local community perceive household solid waste management as a problem? And why? - What are the roles of the female individual and youth in solid waste management both at the household and community level? - What are the historical changes in waste type and disposal practices in the area? - What are the perceptions of the locals on waste collection and waste treatment by local authorities and the government?
Key findings	Not available yet
Main recommendations	Not available yet
Researchers	Alin Kadfak, Swedish supervisors and Ghanaian Co-supervisor: Dr. Noah Adamtey, Ghana Atomic Research Centre
Year	2010-2011

Project title (6)	Assessing Institutional stakeholder capacity for the implementation of Environmental Sanitation Policy of Ghana (2010): Case study of solid waste management in Accra and Koforidua
Research type	MSc project
Institution/department	SLU and Uppsala University
Objectives	The aim of the study is to access the role of the major actors in solid waste management in relation to the ESP, 2010, through a case study of Accra and Koforidua. In order to achieve the aim of the research, the following objectives have been outlined; 1. To investigate the procedure in the making of the ESP, 2010 2. To identify major actors and access their roles in solid waste management relation to the ESP 3. To assess the capacity of the actors in solid waste management in relation to their roles in the ESP.
Key findings	Not available yet
Main recommendations	Not available yet
Researchers	Linda Appiah Boamah
Year	2010-2011

Project title	GIS analysis of decentralized versus centralized composting in Kumasi, Ghana
Research type	MSc project
Institution/department	SLU, Department of Energy and Technology and KNUST, Department of Chemical Engineering
Objectives	The aim of the study is to investigate the opportunities for transforming transfer stations and abandoned dump sites into decentralized composting sites and waste sorting stations. This is done by mapping and classifying these locations, assessing their suitability for composting or sorting, and analyzing the potential savings in waste transportation.
Key findings	Not available yet
Main recommendations	Not available yet
Researchers	Hanna Öberg, supervisors Cecilia Sundberg, and Dr. Moses Mensah, KNUST
Year	2010-2011

Project title	Waste Management System for Western Africa Analysis of systems successfully applied in the world that may fit the reality faced in Western Africa
Research type	MSc project
Institution/department	SLU, Department of Energy and Technology
Objectives	description of systems and technologies for (i) waste collection and transport, and (ii) treatment and disposal of the organic fraction of municipal waste,

	Comparison and evaluation of their sustainability aspects for application in West Africa
Key findings	Creation of cooperatives and MSEs (micro and small enterprises) for collection and transportation should be strongly be encouraged. Promising technologies are home composting, decentralised composting and centralised composting
Main recommendations	As for the treatment of solid household waste, the focus on organic matter should be on the combination of decentralized composting and home composting with plastic bins. For any new waste management scenario to be applied in Western Africa countries, it is important for the stakeholders that support this project to have in mind that a sustainable waste management system should not be just environmentally, but socially and economically designed.
Researchers	Michele Adamoski, supervisor Cecilia Sundberg
Year	2010-2011

Project title	Composting of Municipal Waste in South Africa
Research type	MSc project
Institution/department	SLU and Uppsala University
Objectives	The aim of the study was to map some municipal initiatives in composting of solid waste and, based on these case studies, describe how the composting projects were fulfilling the goals of the municipalities. By doing so, we aimed to reduce the gap between policy and implementation by establishing contacts and making the experiences from already running composting projects available for actors that are planning to further develop, or start up new, composting facilities in South Africa. Aspects included were technological process, environmental impact, economic sustainability and social policy fulfillment
Key findings	Social policy fulfilment: There was an overall high awareness of the importance to fulfil social policy goals. The strategies differed between organisations, and the projects with municipal involvement seemed to be more ambitious The relatively small environmental impact of the composts, together with the insufficient reinforcement of the environmental legislation meant that very little was done to prevent environmental impacts of the visited compost projects. Economic sustainability: None of the visited projects were yet self- sustainable, partly because most of the projects had not been running for very long. The private companies were seeing great potential in the business and are hoping to soon break even. The municipality-driven projects were, by calculating with the savings in costs for alternative treatment of the waste, in some cases making over all savings already Technological process: The quality of the end product varied

	between the projects, depending on the type of incoming material, pre-treatment of the waste and level of process control. The process control was affected by knowledge of the process, standard and breakage frequency of the machinery, what measurements were taken and how regularly. All of the projects produced a product that has a market and most projects have incentives to sell their product before it has matured. The end uses and the customers ranged from padding in municipal projects to homeowners and organic farmers.
Main recommendations	It is important with a good source separation of the waste, both to get a good process, a high quality product and to reach sufficient volumes. Factors affecting this is public awareness and motivation among the staff working at the drop offs. If the persons responsible for the separation of the received waste are responsible for the whole composting process, a better result is reached. When this is not the case education and motivation for the staff at the drop of site is important. A paved surface is recommended since it improves factors such as working condition, control of leachate and organic content but we are aware that this is very costly and that it therefore is not seen as an option for many of the composting projects. When municipalities are calculating the economical viability of compost, the saved costs from alternative treatment of the waste should be taken into consideration in order to get a just picture of composting as an alternative to landfill. Regarding large scale projects, we also recommend that financial means should be allocated for process measurements and quality control in order to be able to produce a better product and to be prepared to deal with more complicated waste. For social policy fulfillment, a key factor in the process is the transference of formal and informal knowledge and management responsibilities. If the main goal is to promote social policies, we therefore recommend the organizational form of co-operatives.
Researchers	Lotten Ekelund and Kristina Nyström, supervisors Cecilia Sundberg, Eric Zinn, Håkan Jönsson
Year	2007

Project title	Improving compost process efficiency by controlling aeration, temperature and pH
Research type	PhD project
Institution/department	SLU, Department of Energy and Technology
Objectives	The overall objective was to increase knowledge of methods to improve the turnover in practical bio waste composting. Specific objectives were to improve the understanding of acid-related process inhibition and methods for abatement of such inhibition in relation to temperature; in fed-batch composting; and in large-scale batch composting. A further objective was to investigate

	the effect of composting temperature on carbon and nitrogen turnover, and the final objective was to construct and test a mathematical model of the microbial kinetics of composting during an initial low-pH phase.
Key findings	In both fed-batch composting and batch composting of food waste, a prolonged acidic phase can occur, resulting in low degradation in composting processes. Inhibition of thermophiles at low pH is an important key to explaining the lag in the transition from mesophilic to thermophilic conditions in the initial phase of batch composting. The dynamics during the initial self-heating phase of batch composting can be modeled as a process governed by a mesophilic microbial community tolerant to low pH and a thermophilic community inhibited by low pH. The acidic phase can be shortened by (i) Keeping the temperature low, below the mesophilic optimum (ii) Increasing the aeration rate, even if the temperature remains above the mesophilic optimum (iii) Mixing the fresh substrate with compost (iv) Adding alkaline substances When composting source-separated household waste at 40, 55 or 67 °C, the decomposition of organic matter during the high-rate phase is fastest at 55 °C. There is little difference in decomposition rate at 40 and 67 °C. In controlled reactor experiments, the ammonia emissions at 67 °C were more than double those at 55°C, and they were higher at 55 °C than at 40 °C. It is thus important to keep the temperature down in order to minimize the ammonia emissions.
Main recommendations	When composting waste with an initial low pH, the pH value is an important process parameter, firstly because it is correlated to the decomposition achieved and the stability of the compost, and secondly because the optimal process temperature depends on pH. Concentration of O_2 and CO_2 have a limited value as process control parameters, since they vary very little even when differences in decomposition rate are large. However, heat production, O_2 consumption and CO_2 emission are valuable process control parameters. • Experimentation at different scales is an efficient experimental strategy, but requires that thermal issues be properly addressed, since the conductive-radiative heat losses vary between scales, and this affects the relationship between temperature, O_2 concentration and moisture
Researchers	Cecilia Sundberg
Year	2005

Project title	Minimization of odour from composting of food waste through process optimization – a Nordic collaboration project
Research type	Post-doctoral research
Institution/department	SLU, Department of Energy and Technology
Objectives	Provide advice on how composting processes should be designed and operated so as to: • Minimise the risk of odour problems during the process • Minimise the risk of odour problems with the finished product • Achieve an efficient and reliable process • Achieve a high and uniform product quality in composting of source-separated household waste in the Nordic countries
Key findings	The incoming food waste in the Nordic countries is characterized by low pH values, which cause a high risk of problems during composting of the waste. In terms of water contents, gas-filled pore volumes and organic carbon and nitrogen contents The substrate mixtures were suitable for composting Gamma-proteobacteria is the dominating bacterial group, and lactic acid bacteria are also common, and may cause problems by acid production. Bacterial groups required for an efficient process, i.e. *Bacillus* and Actinobacteria, are present in the waste. Odor concentration was higher at low pH and there was a statistically significant correlation. Odor potential, is greater in material that has pH < 6.0 than in material that has pH >6.6, but within each group there is no significant correlation between odor and pH. Increased air flow both cool the compost and increases the oxygen supply, both of which contribute to a more effective process with a faster pH increase and thereby decreased pore odor.
Main recommendations	Management recommendations: Acid compost produces more odor than neutral – increase pH rapidly. Possible measures to increase the pH: Increased aeration Addition of pH-increasing material: recycled compost and structure material; ash and/or lime Improve decomposition efficiency in the enclosed main process: With a fast process, a large proportion of the odor formation occurs in the enclosed part of the composting plant. Add water to the process: A fast decomposition process requires much air and water, since food waste is a very energy rich substrate. There is a high risk of compost drying out, so water must be added during the course of the process Introduce a measuring programme for process control: temperature, pH, dry matter content, air flow rate Odor should be treated as an integral part of plant management
Researchers	Håkan Jönsson and Cecilia Sundberg at SLU, and several other researchers
Year	2005-2008

2.6. Öko-Institut e.V. – Institut für angewandte Ökologie (OEKO)

Founded in 1977, Öko-Institut, a non-profit organization, has played leading roles in research and consultancy in technologies for realising the vision of sustainable development globally, nationally and locally. OEKO aims to use our ideas, understanding and knowledge to persuade relevant stakeholders of the changes that must be made and help them to move in the appropriate direction. The institute conducts around areas such as chemicals management and technology assessment, energy and climate, emission and ambient pollution control, radiation protection, agriculture and biodiversity, sustainability in consumption, mobility, resource management and industry, nuclear engineering and facility safety as well as law, policy and governance.

To implement its numerous projects and to achieve its mission and objectives, Öko-Institut employs more than 125 staff, including more than 85 researchers in Freiburg, Darmstadt and Berlin. OEKO has good working partnerships with federal agencies and industry in Germany, the European Union, and a host of organizations outside the EU. Since OEKO is also an association with a membership of over 2500 individuals and local authorities, it has achieved financial independence owing to kind contributions from its members.

OEKO has gained expertise in solid waste management over the years. In Ghana and Nigeria Öko-Institut has examined how e-waste can be recycled in ways that are environmentally sound and also meet social standards.

OEKO is the coordinator for work package 1 which involves the identification of common criteria for characterizing regions in the targeted countries with regards to the socio-economic situation and policy backgrounds, stakeholders involved in SWM, and SWM practices and technologies. OEKO is also playing leading roles in task 2.5 – identification of major barriers to ISWM, and task 3.1 – identification of international best practices in European and non-European countries. Moreover, OEKO will preside over the development of policy guidelines under work package 4. Finally, OEKO and SLU will write a paper on barriers and impediments to successful SWM in the targeted countries.

2.7. Enda Tiers Monde (ENDA)

ENDA is an international NGO, founded in 1972 in Dakar, but is responsible for developing and implementing projects that have the potential to alleviate poverty among local communities in Africa, the Caribbean, South America, and Europe. It was initialled supported financially by UNEP, African Institute of Economic Development and Planning, and Swedish Organisation for International Development.

With over twenty years of experience in waste and environmental management, ENDA has gained considerable expertise in implementing international conventions on environment, including climate change and desertification, at the local level. The NGO has played key roles in major EC projects such as PRECEUP, which was aimed at developing grassroots initiatives on urban environmental management in nine countries in Africa, Asia, and South America.

ENDA's role in IWWA is to lead the development of criteria for identifying relevant key stakeholders in task 1.2, and the assessment and characterization of SWM conditions in the targeted countries in task 2.1. ENDA is also a participant in mapping and evaluation of current research as well as the identification of stakeholders in the targeted countries. The NGO will also organize stakeholders' workshop in Senegal, and will also support MATAM to develop a case study focusing on the feasibility of applying recommendations of the IWWA project to the municipality of MATAM.

Project title (1)	Keyboards for all? Not at any price... towards a responsible digital solidarity
Research type	Awareness-raising campaign based on a field study
Institution/department	Enda Europe (France) in partnership with Enda Tiers Monde/Ecopole (Senegal) and Enda Graf Sahel (Senegal), as well as Waste Stichting (Netherlands), CF2M (Belgium) and Les Petits Débrouillards (Belgium).
Objectives	To study the practices of second-hand ICT equipment donations especially in Senegal To raise awareness on the issue of e-waste
Key findings	There are important flows of ICT equipment donations from the EU, especially from France, towards Senegal; yet the non-profit organisations behind these donations are mostly small and poorly organised except for a dozen of major NGOs. There are even more important flows of ICT equipment transfers by private business organisations yet this was not covered by the scope of the study.
Main recommendations	Enda Europe and its partners published a study with general recommendations in 2008 and a manual with practical guidelines in 2010. Both documents can be downloaded: http://ewasteguide.info/keyboards-for-all
Researchers	Ivo Haenen (Waste Stichting), Lucie Guillet (Enda Europe), Abdou Diouf (Enda Graf Sahel)
Year	2008-2011
Project title (2	Towards social protection and inclusion of informal waste pickers and recyclers in Southern cities
Research type	Action-research

Institution/department	Enda Europe, in partnership with Enda Ethiopia, Enda Océan Indien, Enda Vietnam and Enda Colombia
Objectives	Overall objective To improve social inclusion and ensure a sustainable access to a more adequate social protection system for informal waste pickers and recyclers (IWPRs) in Madagascar, Vietnam, Ethiopia and Colombia. Specific objectives To improve the working conditions of the informal IWPR, reducing risk factors on health To improve the access to health insurance and services -for IWPRs at local level. To insert or stabilize 50 WPRs organizations into integrated waste management systems
Key findings	The research has just started.
Main recommendations	No recommendations so far.
Researchers	Fabricia Devignes (Enda Europe), Annelaure Wittmann (Enda Europe), Federico Parra (Enda Colombia), Noro Razafindraza (Enda Océan Indien), Xuan Nguyen (Enda Vietnam), Azeb Girmai (Enda Ethiopia)
Year	2001-2013

2.8. African Institute of Urban Management (IAGU)

IAGU is an international NGO founded in 1987. The NGO has an executive secretariat based in Dakar. IAGU participates in projects that focus on research and development, technical report preparation, training and information in environmental planning and management, urban agriculture, household and hazardous waste management, and urban environmental health, among others. It supports metropolitan, municipal and local authorities in West and Central Africa in planning and management capacities with aim to improving local governance, improving local livelihoods, and promoting sustainable development. IAGU also specializes in building capacity of local authorities in urban management as well as conduction feasibility studies of projects in urban settings.

In IWWA, IAGU is involved in, among others: development of criteria for identifying stakeholders in SWM and for assessing the socio-economic condition and policy background in the targeted countries, and the identification of key stakeholders along the entire chain of SWM. IAGU is also involved in cataloguing of on-going research in the target countries along the themes of IWWA, and the development of policy guidelines and recommendations for national and regional action plans.

Name of research centre	Centre Régional de la Convention de Bâle pour les Pays Francophones d'Afrique / IAGU
Country	Senegal
Department	
Contact person	
Email	
Title of project	Projet Probo Koala de Côte d'Ivoire/Renforcement des capacités de contrôle des mouvements transfrontières dans des pays côtiers
Objectives	
Short description	
Key findings	
Publications	

Name of research centre	Centre Régional de la Convention de Bâle pour les Pays Francophones d'Afrique / IAGU
Country	Senegal
Department	
Contact person	
Email	
Title of project	Projet Déchets Equipements Electriques et Electroniques (DEEE) en Afrique
Objectives	
Short description	
Key findings	
Publications	

Name of research centre	**IAGU**
Country	Senegal
Department	
Contact person	Dr. Oumar Cissé
Email	
Title of project	Site d'enfouissement de Mbeubeuss : à la recherche de la santé humaine, la santé environnementale et les moyens de subsistance (Sénégal)
Objectives	
Short description	See website: http://www.idrc.ca/fr/ev-83062-201_103801-1-IDRC_ADM_INFO.html
Key findings	
Publications	

2.9. Zoomlion Ghana

Zoomlion Ghana Limited is the biggest waste management and environmental sanitation company in Ghana. It has working operations in other African countries including Ivory Coast, Togo, Benin, Senegal, Nigeria, Guinea, Liberia, Sierra Leone, Zambia and Angola. The Company was formed in 2006 and currently has core staff number of over 2,800, and manages about 63,000 workers under various forms of Public Private Partnerships (PPP). Zoomlion has provided janitorial services in international sports competitions such as the Africa Cup of nations in Ghana in 2008 and the recent Africa cup of nations in Angola.

Zoomlion Ghana works with government, local authorities and communities, other private companies, academia to deliver high quality services aimed at preventing environmental pollution and safeguarding public health, including solid waste collection and disposal and treatment, drain cleaning, street sweeping, and liquid waste collection and disposal.

Zoomlion has research and working relationships with several international companies such as TEDCOR limited of South Africa, Nehlsen of Germany, and Zoomlion and Hubei of China. The company also participates in other programmes such as National Youth Employment Programme, National Forest Plantation, and beach cleaning and reforestation.

In IWWA, Zoomlion is involved in regional assessment of solid waste practices and technologies in the targeted countries. Zoomlion will bring to bear its vast experience in solid waste collection, treatment and disposal in Ghana and other countries where they operate. Zoomlion will provide support to other partners to identify stakeholders and the identification of barriers to good practices in SWM in Ghana. They will also assist other Ghanaian partners to organize workshops as enshrined in the IWWA document, and the final conference in Accra.

2.10. Eidgenoessische Materialpruefungs – Und Forschungsanstalt (EMPA)

EMPA is an interdisciplinary research and services institution for material sciences and technology development in Switzerland. EMPA directs its research and development to meet the requirements of industry and the needs of society, and link together applications-oriented research and the practical implementation of new ideas, science and industry, and science and society. The thematic areas of research at EMPA are along the following topics: Nano-structured materials, sustainable built environment, health and performance, natural resources and pollutants, and materials for energy technologies. EMPA's activities are guided by the following watchwords - safety, reliability and sustainability of materials and systems.
EMPA has played leading roles in a number of projects in developing countries with the aim of building capacity of countries and local communities in e-waste management with regards to policy and legislation, business and financing, and technology and skills development.

In IWWA, EMPA will provide support to the African partners to develop guidelines for ISWM implementation in the targeted countries. EMPA will bring to bear best practices in Europe which can be applied to the targeted countries. EMPA will play a leading role in task 2.4 which deals with the evaluation of SWM practices in the targeted countries.

Title of Project (1)	A review of the environmental fate and effects of hazardous substances released from electrical and electronic equipment during recycling: Examples from China and India
Research Type	Journal Article
Institution/Departement	Swiss Federal Laboratories for Materials Science and Technology (EMPA)
Objectives	Review of data found in the scientific and grey literature about concentrations of lead (Pb), polybrominated diphenylethers (PBDEs), polychlorinated dioxins and furans as well as polybrominated dioxins and furans (PCDD/Fs and PBDD/Fs) monitored in various environmental compartments in China and India, two countries where informal WEEE recycling plays an important economic role Comparison of data with known concentration thresholds and other pollution level standards to provide an indication of the seriousness of the pollution levels in the study sites selected and further to indicate the potential negative impact of these pollutants on the ecosystems and humans affected
Key findings	The concentration levels found sometimes exceed the reference values for the sites under investigation and pollution observed in other industrial or urban areas by several orders of magnitude. These observations suggest a serious environmental and human health threat, which is backed up by other studies that have examined the impact of concentrations of these compounds in humans and other organisms. The risk to the population treating WEEE and to the surrounding environment increases with the lack of health and safety guidelines and improper recycling techniques such as dumping, dismantling, inappropriate shredding, burning and acid leaching. At a regional scale, the influence of pollutants generated by WEEE recycling sites is important due to the long-distance transport potential of some chemicals.
Main recommendations	Although the data presented are alarming, the situation could be improved relatively rapidly by the implementation of more benign recycling techniques and the development and enforcement of WEEE-related legislation at the national level, including prevention of unregulated WEEE exports from industrialised countries.
Researchers	Sepúlveda, A, Schluep M, Renaud FG, Streicher M, Kuehr R, Hagelüken C, Gerecke AC
Year	2010
Title of Project (2)	Recycling - From E-waste To Resources
Research type	Sustainable Innovation and Technology Transfer Industrial Sector Studies
Institution/department	United Nations Environment Programme
Objectives	Analysis of the market potential of relevant technologies for the e-waste recycling sector in selected developing countries Examination of the application of the 'Framework for UNEP Technology Transfer Activities in Support of Global Climate Change Objectives' in order to foster the transfer of innovative technologies in the e-waste recycling sector Identification of innovation hubs and centres of excellence in emerging economies relevant for e-waste recycling technologies.
Key findings and	Kenya, Uganda, Senegal, Peru are classified as promising for

recommendations	the introduction of pre-processing technologies with a strong support in capacity building India and China are classified as having a significant potential for the introduction of pre- and end processing technologies with a strong support in capacity building in the informal sector South Africa, Morocco, Colombia, Mexico, Brazil are classified as having a significant potential to adapt pre- and to some extent end processing technologies to their own needs, following a technology and knowledge exchange
Researchers	Schluep, M, Hagelueken C, Kuehr R, Magalini F, Maurer C, Meskers C, Mueller E, Wang F
Year	2009
Title of Project (3)	e-Waste assessment in Uganda: A situational analysis of e-waste management and generation with special emphasis on personal computers
Research type	Technical report
Institution/department	Uganda Cleaner Production Center, Empa
Objectives	Provide the necessary data to define a solution for handling the e-waste associated with the UNIDO/Microsoft refurbishment project. Provide general data about the e-waste situation in Uganda and thus the study should also serve for further initiatives by other stakeholders, e.g. for the developing a policy framework, etc.
Key findings	Due to the relatively young development of Uganda in ICT equipment, until now, the country mainly was building up stocks of end-of-life computers, which are entering the waste stream only in small quantities. The investigation shows that large quantities of obsolete equipment are in stock and it is expected that considerably more e-waste will show up on the street in short time
Main recommendations	It is the right time for Uganda to engage in addressing the problem of increasing e-waste volumes. Waiting too long with actions bears the risk of a developing informal sector, with all its social and environmental drawbacks
Researchers	Wasswa, J, Schluep M
Year	2009
Title of Project (4)	E-waste Management in Kenya
Research type	Technical report
Institution/department	Kenya ICT Action Network (KICTANet)
Scope & Objectives	Through a literature review, a survey, field visits and interviews, as well as a series of stakeholder workshops, this study estimates e-waste flows in Nairobi, and makes national assumptions. It analyses the policy and legislative context affecting e-waste, and looks at its social, economic and environmental impact, including health and safety issues. The study focuses on IT equipment, such as desktop computers, notebooks, printers and related accessories.
Key findings	E-waste is expected to be a major problem in the future, not the least given the rise in IT importation in 2007. E-waste management policies are lacking, and there is no legislation governing e-waste There is a high accumulation of old IT equipment in homes, offices and repair shops because the owners are not aware how to dispose of the equipment, and whether or not it has any

	residual value that they can extract Knowledge on where to discard e-waste is lacking right from the consumer to the final disposer
Main recommendations	The ministry of Environment needs to promulgate policy and specific regulations on e-waste. More awareness should be created on how to dispose unusable equipment through an organised collection and disposal system. They should also establish a mechanism to raise funds for the expensive process of e-waste management.
Researchers	Waema, T, Mureithi M
Year	2008
Title of Project (5)	Technical report on the assessment of e-waste management in Morocco
Research type	Technical report
Institution/department	Moroccon Cleaner Production Center, Empa
Scope & Objectives	Analysis of the local e-waste context in Morocco, a stakeholder analysis, a mass flow analysis as well as an evaluation of social, economic and environmental impacts resulting from the current e-waste management practices Provision of necessary elements for drafting a road map, which would allow to implement a proper e-waste management system Identification of opportunities to create and improve employment in Morocco. The scope of the study covers the entire country, with a special focus on the great Casablanca, Fez and Meknes, where field visits were conducted. The equipments studied in this project are computers (desktop and laptop), mobile phones and televisions.
Key findings	Absence of an organised WEEE management sector The management of this waste in Morocco is worrying, it is not yet alarming Law 28-00, is a good start but is insufficient. A specific decree regulating WEEE management would help improve practices as processing structures are set up. The government and the private sector have devised ambitious strategies for the development of NICT. However, the question of sustainable WEEE management has not been addressed
Main recommendations	Detailed recommendations are given on regulation, for the infrastructure needs of the sector, for information, awareness-raising and education, for information gathering and surveillance of the system and for the responsibility of EEE producers.
Researchers	Laissaoui, S E, Rochat D
Year	2008
Title of Project (6)	Rapport technique de l'état des lieux de la gestion des e-déchets au Sénégal
Research type	Technical report
Institution/department	IAGU, Empa
Scope & Objectives	Define the most relevant stakeholders Map e-waste flows and stocks in the capital, Identify formal and informal actors in the e-waste recovery and recycling chain The study takes a national view on policy affecting e-waste in Senegal, its main focus is on the capital Dakar. It focuses on desktop PCs, notebooks and printers, mobile phones and television sets

Key findings	The largest share of the computer stock in the country is in households, followed by companies and government offices The stock of televisions is by far more important in weight Early assessments suggest that while the Senegalese authorities are aware of the e-waste challenge, mechanisms to deal effectively with e-waste, including policy mechanisms, are not yet in place. While e-waste recycling is largely left up to the informal sector in many developing nations, it seems that many electronic parts are simply dumped and that only some basic fractions are recovered, such as aluminium and lead, rarely plastics
Main recommendations	Set up an institutional structure to manage the e-waste to promote the collaboration of all involved stakeholders Set up a channel for valorisation of e-waste, considering in priority the persons involving in the recuperation activities of waste and e-waste Set up and update a database on the e-waste nformation & awareness building to the large public on the e-waste specificities
Researchers	Wone S, Rochat D
Year	2008
Title of Project (7)	e-Waste assessment South Africa
Research type	Technical report
Institution/department	Openresearch, Empa
Scope & Objectives	This assessment considers three primary e-waste streams: white goods, consumer electronics, and information technology (IT). By focusing on several tracer products in these categories - namely, fridges, washing machines, microwaves, TVs, PCs, printers, and mobile phones The assessment outlines the current e-waste situation in South Africa. It also briefly considers the status of fluorescent discharge lamps, and rechargeable batteries used in electronic products.
Key findings	It suggests that white goods are likely to become a major feature of e-waste volumes in the future - even surpassing IT as a tonnage percentage of the waste stream The assessment estimates that white goods, consumer electronics and IT in South African homes amount to anything between one million and two million tons, most of which is likely to enter the waste stream in the next 5-10 years While storage of e-waste in institutions such as government departments and universities is reported to be high, the domestic storage of e-waste is also substantial South Africa faces a number of recycling challenges when it comes to e-waste. These include dealing with hazardous fraction, such as Cathode Ray Tube (CRT) glass, and finding markets for flame-retardant plastics. Liquid Crystal Display (LCD) monitors are also likely to present a key challenge in the future Basic environmental precautions are absent at some recyclers, and health and safety regulations are loosely enforced. Finally, it shows that informal e-waste recycling includes mostly the early stages of recycling - collection, crude dismantling and sorting. Informal recyclers are vulnerable, often deal with e-waste in a hazardous way, and are open to exploitation.
Main recommendations	Amongst other things, the assessment recommends the scaling

	up of public awareness campaigns that spell out the hazards of e-waste, the active engagement of all stakeholders in the current drive by e WASA to establish an e-waste management system, the support of small business start-ups and informal recyclers, and support for the investment in new recycling technology through incentives.
Researchers	Finlay, A, Liechti D
Year	2008
Title of Project (8)	Assessing cost implications of applying best e-waste recovery practices in a manual disassembly material recovery facility in Cape Town, South Africa, using process-based cost modelling
Research type	Master Thesis
Institution/department	EPFL, Empa
Scope & Objectives	The aim of this study is to assess the identified associated risks and problems and define the terms of locally available best practices for e-waste recovery and recycling within the Cape Town “Green e-waste channel”. The findings will be utilized to propose a system description for a large scale manual disassembly facility. In a second step Process-Based Cost Modelling (PBCM) is used (incorporating product characteristics as well as volume, composition, destination and value of outgoing material streams) in order to calculate cost implications of implementing the identified best practices in a large scale manual disassembly and material recovery facility (MRF).
Key findings	Formalized and controlled manual disassembly of e-waste in a large scale specialized material recovery facility is an excellent way to shift from informal backyard recycling to safe and environmentally friendly practices In the case of monitors and printers, proper handling of those waste streams results in additional costs. However processing those items by dismantling them contributes significantly to the reduction of required landfill space and closes material cycles The implementation of a material recovery facility is an excellent way to substitute irregular incomes linked to informal sector activities of the previously disadvantaged population with stable and properly registered jobs ultimately leading to capacity building, poverty alleviation and crime reduction and therefore local economic growth.
Researchers	Laffely, J
Year	2007
Title of Project (9)	The Green e-Waste Channel: model for a reuse and recycling system of electronic waste in South Africa
Research type	Master Thesis
Institution/department	Uni Lausanne, Empa
	This study proposes a model through a Green e-Waste Channel by defining the role of possible stakeholders. The Channel is defined as the infrastructure and the processes needed to reuse and recycle e waste. The main stakeholders are refurbishers, collectors and processors. Producers, the government and NGOs can support the Green e-Waste Channel through a management, legislative and facilitative process. The potential role of each stakeholder is discussed. The viability of the model of a Green e-Waste Channel in South

	Africa was assessed through a SWOT analysis (Strengths, Weaknesses, Opportunities and Threats).
Key findings	The analysis shows that the model reveals many opportunities with advantages for all stakeholders: a) sufficient material can be provided to processors and refurbishers, b) safe jobs can be created, c) a convenient solution can be provided for the consumers d) a solution for end-of-life equipment can be offered for the producers, and e) the channel helps respecting national and international regulations. In addition the current situation in South Africa is favourable for a successful introduction of a Green e-Waste Channel: the e-waste situation is relatively clean, with limited import and informal recycling, and there is a general move towards more sustainable waste management.
Researchers	Bondolfi, A
Year	2007
Title of Project (10)	Mass flow assessment (MFA) and assessment of recycling strategies for cathode ray tubes (CRTs) for the Cape Metropolian Area (CMA), South Africa
Research type	Master Thesis
Institution/department	ETH Zurich / Empa
Scope & Objectives	Cathode ray tubes (CRTs) are a major problem for further recycling in South Africa. At this stage, an economically feasible and environmentally sound recycling process is not available. CRTs are currently dumped or landfilled. The aim of this study is to provide background information for the future management of CRT screens in South Africa. Thus, a mass flow assessment (MFA) of cathode ray tube computer monitors and TVs for the Cape Metropolitan Area (CMA) based on the year 2005 was carried out. In addition, time series were calculated to forecast future figures of obsolete CRT devices. In a second step, local and best available recycling alternatives for the recycling of CRT glass were specified and assessed towards their sustainability using the Multi Attribute Utility Theory (MAUT) methodology. From the best available technologies, the use of CRT glass in the production of new CRTs and the use of CRT glass in the copper/lead smelting process were included in recycling scenarios. Together with the local option, eight scenarios were assessed using the MAUT methodology. A set of attributes was defined to evaluate the scenarios including economical, environmental and social attributes.
Key findings	The results of the MFA showed a significant consumer stock growth of both CRT monitors and TVs. Only little CRT devices are disposed of at landfill sites. The obsolescence will increase until 2020 for CRT computer monitors and for CRT TVs until 2020 to 2030. It is expected that in the year 2007 some 400 tons of CRT monitors and 600 tons of CRT TVs will become obsolete. The dismantling of CRT monitors and TVs is already established and economically feasible. Only the CRT cannot be recycled at this stage and is therefore landfilled. For the future recycling, local brick manufactures and the building industry is able to use

	the CRT glass in their processes. Neither the assessed, local metal smelters nor glass manufacturers were prepared to use CRT glass in their processes. The study shows that the manufacturing of new CRTs from recycled CRT glass is the best option in terms of sustainability. As second best option the lead recovery from CRT glass was identified.
Researchers	Zumbühl, D
Year	2006
Title of Project (11)	Ghana e-Waste Country Assessment
Research type	Technical Report
Institution/department	Green Advocacy Ghana, Empa
Scope & Objectives	To improve the level of information available on flows of e-waste and EEE being imported into Ghana. To improve decision making and increase communication between exporting and importing countries. To undertake a national assessment of new, used and end-of-life EEE. To assess e-waste management practices in the formal and informal sectors. To describe the legal and regulatory frameworks in place. To assist to develop environmentally sound management policies for nationally generated e-waste. To assess needs towards environmentally sound management.
Key findings	Regarding the various stages of the mass flow; import, consumption, repair, collection, recycling and disposal, it became clear during the study that the main problems and challenges lies within the import as well as the recycling and disposal stage. Based on the available import data, it was estimated that up to 70% of all EEE imported are second hand products, around 60 - 70% of these second hand products arrive in working condition, another 20-30 % can be repaired or refurbished to get them functioning and about, 10 - 20% are broken and sent directly to the informal recycling. There is certain awareness on environmental impacts of wrong disposal of WEEE among the consumers, especially within Accra, but due to the lack of environmentally sound disposal options, most obsolete equipment is either given to the informal collectors or stored. A high proportion of devices becoming obsolete are brought to repair shops instead of immediate disposal. The repairers, having a high success rate in repairing certain EEE, contribute to a significant extension of the lifetime of those devices and therefore to a reduction of the WEEE generated. The informal door-to-door collectors are able to collect a high amount of WEEE generated in Ghana. Within the recycling and disposal stage, WEEE is dismantled and sorted into various valuable and non-valuable fractions. Non-valuable fractions are informally dumped and periodically burnt, in order to reduce the waste volumes on the dump site. During these activities, high amounts of hazardous substances are released, with no thoughts given to the safety of the workers and the protection of the environment. This leads to significant negative impacts on soil, air and water as well as human health. The preliminary estimation of total

	dioxin (PCDD/F) emissions to air from open cable burning alone in the Greater Accra Region amounts to a source strength of ~3 g / year. This equals to 7.5 – 15 % of European dioxin emissions from industrial waste incineration.
Recommendations	All findings of the Ghana e-Waste Country Assessment were incorporated in the National Strategy document that gives recommendations on the following elements: Policy and Legislation, Business and Financing, Technology & Skills, Monitoring & Control and Marketing, Awareness & Education. The National Strategy also includes a roadmap how to build up a national e-waste management system.
Remarks	Draft Report, not yet available
Researchers	Amoyaw-Osei, Y, Agyekum, O, Mueller, E, Fasko, R, Schluep, M.
Year	2011
Title of Project (12)	Project DEEE Afrique du Secrétariat de la Convention de Bâle
Research type	Technical Report
Institution/department	CECAF International, Sofies, Empa
Scope & Objectives	To improve the level of information available on flows of e-waste and EEE being imported into Ghana. To improve decision making and increase communication between exporting and importing countries. To undertake a national assessment of new, used and end-of-life EEE. To assess e-waste management practices in the formal and informal sectors. To describe the legal and regulatory frameworks in place. To assist to develop environmentally sound management policies for nationally generated e-waste. To assess needs towards environmentally sound management.
Key findings	Not yet available
Recommendations	Not yet available
Remarks	Draft Report, not yet available
Researchers	Messou, A., Rochat, D. et al.
Year	2011
Title of Project (13)	Nigeria e-Waste Country Assessment
Research type	Technical Report
Institution/department	BCRC, Empa
Scope & Objectives	To improve the level of information available on flows of e-waste and EEE being imported into Ghana. To improve decision making and increase communication between exporting and importing countries. To undertake a national assessment of new, used and end-of-life EEE. To assess e-waste management practices in the formal and informal sectors. To describe the legal and regulatory frameworks in place. To assist to develop environmentally sound management policies for nationally generated e-waste. To assess needs towards environmentally sound management.
Key findings	Not yet available
Recommendations	Not yet available
Remarks	Draft Report, not yet available
Researchers	Osibanjo, O, Schluep, M. et al.

Year	2011

2.11. Kwame Nkrumah University of Science and Technology (KNUST)

KNUST is a leading institution of higher learning and research in Ghana and Africa, and has a student population of over 20,000. Its teaching faculty, numbering over 750, comprises expertise in several fields of learning including humanities, natural and health sciences, mathematics, business and engineering. Researchers at KNUST are well known for their top-notch research into renewable and natural resources, green energy, environmental sanitation, urban agricultural issues, environmental and health risks associated with urban agriculture and sanitation, mining, deforestation, housing, landscaping, and policy. KNUST also has independent research institutes under the colleges with mandates to conduct research and development on issues bothering on sustainable development. For example, the Technology Consultancy Centre which is under the college of engineering develops and disseminates appropriate technology in Ghana and other countries in sub-Saharan Africa.

KNUST and its national – government, local NGOs, private companies, and communities – and international partners – DFIC, DANIDA, IFAD, World Bank, UN, USAID, and European Commission, among others – have worked on numerous projects and actively involved in Technology Transfer. In the field of environmental sanitation and waste management, the Chemical Engineering Department under Dr. Moses Mensah, has been at the forefront of sustainable technologies for waste reduction, reuse, treatment, and safe disposal.

In IWWA, KNUST plays vital roles in all work packages. KNUST fully participates in work package 1 which sets a framework for the entire project. In task 2.2, KNUST as leader of the task will deliver a report that highlights relevant research on SWM within and outside the consortium partners. KNUST is also playing supporting roles in the organization of the final conference in Accra, in addition to the organization of a capacity building workshop in Ghana that will focus on training of stakeholders with regards to the main tools developed from the project.

Project title (1)	Scheduling of solid waste vehicles: A case study of Kumasi
Research type	MSc Water supply and environmental sanitation
Institution/department	Faculty of Civil and Geomatic Engineering, Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana
Objectives	To determine travel time of solid waste vehicles from collection point to disposal site To determine variations in travel time of solid waste vehicles with: the day of the week, time of the day, distance between the collection point and the disposal site
Key findings	Travel time varies with day of the week, time of day, and distance Most efficient days in terms of vehicle travel times are Thursday, Saturday and Sunday For the weekdays, most efficient day in terms of vehicle travel time is Thursday With the exception of Monday, the differences in mean travel time between Thursday as against Tuesday, Wednesday, and Friday are not significant
Main recommendations	Pick up times should always be in the evening, preferably 8 p.m
Researchers	Samuel Wiafe, Samuel Oduro-Kwarteng (supervisor), E. A. Donkor (supervisor)
Year	2008
Project title (2)	Performance of private solid waste collection companies in Kumasi
Research type	MSc Water supply and environmental sanitation

Institution/department	Faculty of Civil and Geomatic Engineering, KNUST, Kumasi, Ghana
Objectives	To assess the performance of private solid waste collection companies in Kumasi To compare performance (vehicle productivity and utilization) of private solid waste collection companies in Kumasi with the performance of private companies in four other cities (Tema, Tamale, Accra, and Secondi-Takoradi) in Ghana To compare the contribution of private solid waste collection companies in Kumasi and compare with the contribution of private companies in the aforementioned cities in Ghana To assess the factors that influence the performance of private solid waste collection companies in the selected cities in Ghana
Key findings	Average performance in terms of vehicle productivity (tonnes/day/vehicle) of six selected solid waste collection companies in Kumasi was 17.2 and only two out of the six companies performed above average Comparing the average vehicle productivity (tonnes/day/vehicle) of companies in Kumasi to the other four in Ghana, the values were 25.5, 19.4, 17.2, 12.4, and 5.6 for companies in Tema, Accra, Kumasi, Secondi-takoradi, and Tamale respectively Average vehicle productivity (tonnes/day/vehicle) was 16.02 across the cities, and the average performance of companies in Tema, Accra, and Kumasi was above this value. Average performance (vehicle utilization) of the six companies in Kumasi was 62 %, and only 2 companies performed above Average vehicle utilization in Tema, Accra, Kumai, Secondi-Takoradi and Tamale were 89.5 %, 68.8, 62, 45, and 33.7 Private companies contribute about 95 % of solid waste in Kumasi Collection of solid waste by private companies in other cities were 100 %, 95, 78,74, 63 in Accra, Kumasi, Tema, Tamale and Secondi-Takoradi Performance of private solid waste companies are influence by vehicles operations planning and supervision, size of company (number of collection vehicles on road), market share, and traffic conditions.
Main recommendations	Regular assessment of vehicle productivity and vehicle utilization to provide data for monitoring performance Regular training of technical personnel on management capacity such as maintenance and conditions of collection vehicles, vehicle routing planning and supervision of services Award for top leading company in waste collection Study on effect of policies on solid waste collection vehicles
Researchers	Yaayin Boniface, Samuel Oduro-Kwarteng (supervisor), Dr. K. B. Nyarko (supervisor)
Year	2009
Project title (3)	Institutional arrangement for private sector involvement in solid waste collection – a case study of five cities in Ghana
Research type	MSc Water supply and environmental sanitation
Institution/department	Department of Civil and Geomatic Engineering, KNUST, Kumasi, Ghana
Objectives	To assess institutional arrangement of private sector involvement in solid waste collection in five cities (Kumasi, Tema, Tamale, Accra, and Secondi-Takoradi) in Ghana

	To study contractual and private arrangements, and regulatory framework for involving for involving private solid waste companies in waste collection in the selected cities
Key findings	House to house service is better than communal Companies do not undergo competitive bidding when contracts expires Assemblies are not able to pay companies on time, and this leads to poor service delivery Companies and assemblies do not strictly adhere to contract obligations Even though laws on sanitation are available to sanction offenders, they are not strictly enforced User fees set are not reasonable to recover cost especially the medium to low class residential areas 19 private solid waste companies (out of 25 selected for the study from a total of 46 in the five cities) receive subsidies from the Assemblies for the house to house service, and 6 companies do not receive such financial assistance Companies operate under two main contracts – franchise and service contracts; duration for contracts are usually 2 and 5 yrs for franchise and service contracts respectively Physical analysis of solid waste in selected high income communities in Kumasi
Main recommendations	Much attention to be devoted to solid waste aspect of urban management Institutional strengthening of decentralization and private sector participation in solid waste management
Researchers	Gyapong-Korsah Barbara, Samuel Oduro-Kwarteng (supervisor), Dr K. B. Nyarko (supervisor)
Year	2009
Project title (4)	Co-composting of organic solid waste and sewage sludge – a waste management option for KNUST campus
Research type	MSc Environmental Science
Institution/department	Department of Environmental sciences, Faculty of Biosciences, KNUST
Objectives	To investigate suitability of co-composting organic solid waste with sewage sludge as a waste management option for KNUST using the Windrow (pile) composting method To assess quality of compost produced from organic solid waste and dewatered sewage sludge as a waste management option To determine optimum ratio of sludge to solid waste that gives good compost To compare physical, chemical, and some biological properties of different ratios of average solid waste to dewatered sludge
Key findings	Dewatered sewage sludge and organic solid waste were mixed in ratios – 1:, 1:2, 1:3, 0:1, and 1:0 sludge/organic solid waste Compost pile ratio 1:3 attained the highest temperature (64 ^{o}C) necessary for composting Ratios 1:2 1:3, and 0:1 maintained a temperature of 55 ^{o}C and above Composting sewage sludge alone did not attain the temperature required Ratio 1:1 and 1:0 had relatively high pathogenic contamination Lettuce produced from soil amended with the compost ratios

	recorded significantly high numbers of faecal coliforms
Main recommendations	Higher proportions of solid waste recommended
Researchers	Kenneth Osei, Dr. Bernard Fei-Baffoe (supervisor, feibaffoe@yahoo.com)
Title of project 5	Scheduling of solid waste vehicles: A case study of Kumasi
Research type	MSc Water supply and environmental sanitation
Department	Department of Civil and Geomatic Engineering, KNUST, Kumasi, Ghana
Objectives	To determine the travel times of the solid waste collection vehicles from collection point to the disposal sites Determine the variations in travel times of the solid waste vehicle with • The day of the week • Time of the day • Distance between collection point and the disposal sites
Key findings	Sunday, Thursday and Saturday were found to be the most efficient day to collect waste during the entire week Thursday was found to be the most efficient day to collect waste on weekdays Time of day also influenced travel time. Collection in the evening was found to be the best as compared to collection during the day
Researchers	Samuel Wiafe Supervisors (S. Oduro Kwarteng and E. A. Donkor)
Year	2008
Project title 6	Assessment of performance of private companies involved in municipal solid waste management in Kumasi
	MSc Water supply and environmental sanitation
	Department of Civil and Geomatic Engineering, KNUST, Kumasi, Ghana
Key objectives	To assess the existing contract and services with respect to ; Collection services contract and services charges Improvement in service coverage arising from Private sector participation and the contributing factors attributed to it To assess the performance of companies involved in solid waste collection services with respect to; Vehicle utilization Collection frequency, planning and supervision Maintenance and downtime of vehicles Revenue collection efficiency Operation ratio and unit cost of services
Key findings	Private participation in solid waste management was found to be over 90% whiles public waste management was found to be about 6-7% Percentage of waste collected in the communal collection system was found to be about 90% of the total waste collected and this was fully sponsored by government Collection coverage was found to be about 71.3% Waste Group Ghana Limited was found to the best in the system since its capacity increased from 36% in 2002 to about 44% and the revenue collected also increase from 15% to 66% whiles the productivity of workers also increased from 3.04 to 3.37 tonnes per worker per day
Researchers	Reuben Ahimbisibwe

Year	2006
Project title 7	Assessment of institutional arrangement for solid waste management in Kumasi
Research type	MSc Water supply and environmental sanitation
Department	Department of Civil and Geomatic Engineering, KNUST, Kumasi, Ghana
Objectives	To establish the change that the environmental sanitation policy has introduced into the institutional arrangement for SWM in Kumasi with respect to; Organisational structure and distribution of functions Development of waste management department staff Participation of the private sector To assess the impact of institutional change on service efficiency in terms of Service coverage and Cost recovery
Key findings	Waste Management Department's role was shifted from direct service provision to supervision and monitoring of private operators Street sweeping and drain cleansing was transferred from Environmental Health Department to Waste Management Department Policy implementation did not make any impact on the development of human resources in the waste management department rather staff of waste management department were found to have undergone various training programmes offered by foreign donors as capacity building component of various sanitation projects funded by the donors Introduction of policy had led to the increase in coverage of house to house collection from 2 % in 1999 to 20.8 % by 2003
Researchers	Peter Appiah Obeng, Supervisors (M. E. Donkor and A. Mensah)
Year	2005
Project title 8	Co-composting of dewatered sewage sludge(Biosolids) and sawdust for agricultural use as an organic fertilizer; A case study of the KNUST sewage plant
Research type	MSc Environmental Science
Department	Department of Environmental sciences, Faculty of Biosciences, KNUST
objectives	To determine the nitrogen, phosphorus, potassium, organic matter, total coliform, faecal coliform and helminth eggs concentration in each co-compost mixture To determine the Nitrogen, Phosphorus, Potassium, organic matter, total coliform, faecal coliform and helminth eggs concentration in each compost type. To quantify the yield of lettuce frown with the various compost type
Findings	Co-composting of dewatered sludge and sawdust reduces pathogens in sewage sludge intended for agricultural purposes Nitrogen was found to be low Compost obtained could not compare with chemical fertilizers on the market No significant difference in quality of compost whether 1:1, 1:1.5 or 1:2 was observed Effective way of reducing volumes of sawdust and sewage sludge since volumes reduced by 50% after the 16 weeks of composting.
Researchers	Baffour-Asare Emmanuel and A. O Anarkwa (supervisor)

Year	2009
Project title 9	Hydrolysis of unsorted municipal solid waste using a percolated reactor mechanism
Research type	Journal of solid waste technology and management, Vol 36, No 4
Department	Department of Environmental sciences, Faculty of Biosciences, KNUST
Objectives	Pre-treat solid waste before dumping in landfill sites Various water flow rate regimes in percolating reactor using unsorted municipal waste as substrate material was investigated
Key findings	Lower leaching and degradation rates were observed for both extreme high and low water flow rate, (1.5 and 1.75 l/kg input waste/day) organic acid production was observed to be the main component of the COD concentration Significant hydrolysis rate on unsorted municipal solid waste may be achieved by selecting the appropriate reactor design Water flow rate of 1.25-1.34 l/kg waste/day results in a minimum degradation rate of 50% A minimum leaching rate of 59% can be obtained at a water flow rate range of 1.25 -1.34 l/kg input waste/day
Researchers	Gunter Busch (busch@tu-cottbus.de) and Bernard Fei-Baffoe (feibaffoe@yahoo.com)
Year	2010

2.12. University Abobo-Adjamé (UAA)

University of Abobo-Adjame was created in 1996 when the National University of Côte d'Ivoire was split into three separate universities: the University de Cocody in Abidjan, the University d'Abobo-Adjamé in Abobo, Adjamé districts of Abidjan, and the University de Bouaké in central Côte d'Ivoire. The University has around 7,000 students training in basic sciences – maths, science, applied sciences. The University of Abobo-Adjamé also offers training for Health Sciences. UAA is noted for its high-level research into overall environmental management including water management. Research into environmental sustainability and management is principally undertaken by Unity of Formation and Research in Science and Environmental Management (UFR-SGE), a unit that carries out research on the following thematic areas: management of renewable and natural resources, urbanization, industrialization and environment; new and renewable energies; and environment and health.

UAA plays a major role in work package 1, identification of criteria for evaluating SWM characteristics of the targeted countries. They will participate in assessment of SWM situation, cataloguing of current research work under task 2.2, identification of stakeholders under task 2.3, and evaluation of SW practices and technologies under task 2.4. Among other commitments, UAA will organize two workshops in Cote d'Ivoire under work package 6.

Project Title (1)	The impacts of Household Waste Management on the ground waters of Abidjan.
Search Type	Diploma of Graduate Studies in Science and Environmental Management: Option: Geosciences and Environment
Institution / Faculty	University Department (UFR) in Science and Environmental Management, University of Abobo-Adjame (UAA), Abidjan Cote d'Ivoire.
Objectives	Assessing the impact of the Household Waste Management on the ground

	waters of Abidjan
Main outputs	At the level of household waste, on 1.2 million tons / produced per day by the city of Abidjan, about 660,000 tones are collected per day. Abidjan Produced about 220.000 m^3 of wastewater per day and 60% of this volume consist of 64,000 kg of DBO pollutant load, spilled out of the sewer system Analysis of 57 fillings shows that the contamination of ground water in Abidjan by nitrates is due gradually from south to north.
Main recommendations	The sheet of Abidjan by the progressive contamination characterized by nitrates from South to North must be kept up with the saturated zone and unsaturated.
Researchers	OUATTARA Lazeni
Year	2007
Publication	Poster presented at international workshop on Waste Management in West Africa, From 12 to 15 May 2008, organized by the University of Abobo-Adjame in collaboration with the University of Applied Sciences Lippe and Höxter Germany. Theme: "Improving the collection, recycling, Processing and setting refute of Waste
Project Title (2)	Comparative Dynamics of Nutrients (N, P) and two solid Storm drains anthropised by industrial and domestic discharges in Abidjan, Cote D'Ivoire
Search Type	Diploma of graduated Studies in Science and Environmental Management: Option: Geosciences and Environment
Institution / Faculty	University department in Science and Environmental Management, University of Abobo-Adjame (UAA), Abidjan Cote d'Ivoire.
Objective	Characterize the fate of nutrients and solids in two storm drains that receive industrial and domestic waste "
Main outputs	The masses of pollutants drained by collectors are low across the Great rainy season. The masses of pollutants drained into the collector in Attécoubé are higher than those of Uniwax concerning the pH of the water in the collector, they decrease in the collector of Uniwax from upstream to downstream and remains more basic than one of Attécoubé which is higher during the rainy seasons
Main recommendations	
Researchers	Beatrice Assamoi Ama (ama_beatrice@yahoo.fr) Lacina Coulibaly (supervisor); Issiaka Savane (supervisor)
Project Title (1)	2009
Publications	European Journal of Scientific Research Vol.25 No. 2 (2009), pp.280-289.
Project Title (3)	Waste Management of garages itinerant in some municipalities (Abobo, Adjamé, Attécoubé, Cocody and Port-Bouet District of Abidjan
Search Type	Diploma of Graduated Studies in Science and Environmental Management: Option: Geosciences and Environment
Institution/Faculty	University department in Science and Environmental Management,

	University of Abobo-Adjame (UAA), Abidjan Cote d'Ivoire. Laboratory of Aquatic Biology and Environment
Objectives	Quantifying the Solid Waste generated by the garages Analyze the management of solid waste in the targeted municipalities
Main Outputs	Wastes generated by the garages are composed of solids and liquids. Vehicles age> 1 year and carcasses present higher amounts of solids. Tires (85.1 tons) Carcasses (575.9 tons) Vehicle age> 1 year (632.7 tons) Plastics (126.5 tons) Glass (2.6 tons) Batteries (34.6 tons) Car bodies are subject to recovery craft.
Main recommendations	the Waste generated by the garages must be valorized
Researchers	Messou Aman (messouaman@yahoo.fr), Lacina Coulibaly., A Ouattara. & Gourene Germain.
Year	2005
Project Title (4)	Physico-chemical pollution of waters in the area of the landfill of Akouédo and risk analysis of groundwater in Abidjan by Model of simulation of flow and transport of pollutants
Search Type	Doctoral thesis
Institution / Faculty	University Department in Science and Environmental Management, University of Abobo-Adjame (UAA), Abidjan Cote d'Ivoire.
Objectives	Quantify the pollutants of the Landfill ; Study "the water quality of forage well field North Riviera (NR) closest to the discharge; Model the transfer of pollutants from a landfill to build assumptions Chemical studies
Main Results	Landfill leachate is the Very Rich in organic matter, Inorganic anions and cations. Organic Matter interest more abundant in surface horizons Routes values that reach 50,000 ppm pour NTK and 4000 ppm pour Corg
Main recommendations	These findings constitute the starting point for work to monitoring the impact of the discharge Akouédo to groundwater. This prediction seems more general and must be strengthened by : Calculation of distribution coefficients of heavy metals in soil, based on modeling the transfer of metals; The study areas of reducing discharge to characterize the principal

	reactions of oxydoreduction in the soil of the landfill; The use of methods for tracing leachate in groundwater to detect water contamination to a long distance.
Researchers	Kouassi Kouamé Innocent
Publications	

2.13. Mairie de Matam (Matam)

Matam is the capital city of Matam, a phosphate-rich region in north-east Senegal, noted for its striking mud architecture. The population of Matam is about 496,207. The municipality of Matam is a traditional and historic city, and is noted for participation in various local and international projects including AGENDA 21 of UNO-habitat, and Network for the development of Sustainable approaches for large Scale Implementation of Sanitation in Africa (NETSSAF) of the European Commission. Matam is headed by a major and it has financial autonomy. The municipality has participated in several projects covering areas in education, health, gender empowerment, income generation activities, and sports.

In IWWA, Matam is involved in Task 1.1 - criteria for evaluation of the regional socio-economic situation and policy background, and task 1.2 - criteria for identification of relevant key stakeholders. Matam is also participating in task 2.1, 2.3, and 2.5. Since Matam has full control of waste management in their territory, they are expected to implement the findings of IWWA within the project time frame in Matam, out of which the results will be shared and discussed with IWWA consortium partners and invited institutions in the final conference in Accra.

2.14. Basel Convention Regional Coordinating Centre for Africa (BCRC), Nigeria

Basel Convention Regional Coordinating Centre for Africa is a national institution with a regional mandate for training, capacity building, and research in the field of control of transboundary movement of hazardous wastes and their disposal. The Centre has mandate to assist African governments to implement the 1989 Basel Convention and the Ban Amendment effectively. In this regard it coordinates the activities of the other three Basel Convention centres in Africa namely BCRC (Egypt) for Arab Speaking Countries, BCRC (Senegal) for French speaking African Countries and BCRC (South Africa) for English speaking African countries. The Centre has focussed on electronic waste, e-waste (inventory, laboratory analysis, environmental impact and modelling of material flow in the supply chain etc); used lead acid batteries (ULAB), used tires, health care waste as well as the recycling of used oils. The centre collaborated with the Basel Action Network (BAN) of USA in producing the famous film: Bridging the Digital Divide - Exporting Arm to Africa. The Centre has also developed a template for the development of a private – public partnership for used oil management in Africa. Recycling of hazardous slag from auto battery manufacture into ceramic tiles and building bricks have also been accomplished by the centre apart from organising regional and national meetings for the Basel Convention and Rotterdam Convention respectively.

BCRC will collaborate on setting the project framework under work package 1. They will participate in the regional assessment of the SWM situation in the target countries, map and evaluate the current research and network, evaluate SWM practices, evaluate the legal background, governance and socio-economic structure, and detect main barriers for ISWM.
Moreover, BCRC will support in the selection of best practices from non OECD countries, in the identification of requirements for the implementation of ISWM systems and in the elaboration of the guide for their implementation. BCRC will also participate in the development of policy guidelines and recommendation. Together with CEIA, BCRC will lead task 5.1 which involves the analysis and assessment of the environmental effects of the measures and recommendations proposed in previous work packages in the different regions characterized in WP2 within the target countries.

Project title (1)	Solid waste composition: The influence of e-waste at Ibadan and Lagos dumpsites.
Research type	MSc Chemistry
Department	Department of Chemistry, Faculty of science, University of Ibadan Oyo State Nigeria.
Objectives	To characterize solid waste at dumpsites To look at the influx of electronic waste into municipal solid waste. To also look at the influence of solid and electronic waste on the soil, plants and water surrounding municipal solid waste dumpsites.
Key findings	The research has shown that waste is increasing and E-waste content is also increasing in our municipal waste. The heavy metal levels found in the dumpsite soil in this study are higher than what is obtainable in normal soils, indicating that the waste is contributing huge amount of toxic metals, nutrients

	and other soil parameters to the surrounding soil. Large quantities of decomposed organic materials significantly influenced the texture and the physiochemical properties of the soil. The texture of soils, high levels of organic matter, available phosphorous, total nitrogen and pH probably influenced the availability and mobility of the metals.
Main Recommendations	Garbage trucks for disposal should be readily made available to collect waste from collection points to dumpsites. The government can help to establish small companies that sell scavenged materials. The private sectors can also become more involved in the collection of waste. The public should be enlightened on the dangers of farming near dumpsites, since it has been established that the plants have the ability to bio-accumulate pollutants in their system.
Researchers	Eggah Nsikak James, Supervisor (professor Oladele Osibanjo))
Year	2010
Project title (2)	Assessment of solid waste, leachate and topsoil of dumpsites in Nigeria, the case of Lagos and Ibadan
Research type	M.Sc Analytical Chemistry
Institution/department	Department of Chemistry, University of Ibadan
Objectives	Characterization of waste deposited at different dumpsites in Lagos and Ibadan Identification of the various sources and assessment of leachate from the dumpsites Assessment of the dumpsite topsoil to ascertain their level of contamination
Key findings	Dumpsites in Lagos has more industrial waste when compared to that of Ibadan Dumpsites in Ibadan had about 90% domestic and 10% industrial waste while it is 80% and 20% in, respectively in Lagos Leachate are partially old, stable and in their early methanogenic phase Most parameters in leachate have very high concentration Concentration of heavy metals in leachate and topsoil exceed the natural range and the control High concentration of persistent organic pollutants (e.g., PAHs and PCBs) in dumpsite leachate and topsoil
Main recommendations	Indiscriminate and co-disposal of other wastes with municipal solid waste should be avoided Public enlightenment and education on the risk associated with farming on dumpsites (both active and abandoned) Recycling and reuse of some of the waste co-disposed with municipal solid waste Proper waste management practices in the country Disposing different waste at different dumpsites and landfill as the case may be

Researchers	Samson Akpotu, Dr. Adebola A. Oketola (Supervisor), Dr. Mary B. Ogundiran (co-supervisor)
Year	2010
Project title (3)	Developing a method of sustainable solid waste management in Ibadan Markets: A case study of Bodija Market
Research type	Ph.D Public Health
Institution/department	Faculty of public Health, Department of Epidemiology, Medical statistics and environmental health, College of Medicine, University of Ibadan
Objectives	To develop a method of sustainable solid waste management in Bodija market with the participation of the traders. To collect baseline data on the existing situation of Bodija market with respect to demographic and socio-economic structure of the traders, knowledge attitude and practice of traders towards waste management. To measure the amount of wastes generated including the physical and chemical characteristics of wastes in the market To conduct an intervention programme involving a selected community (vegetable traders) so as to improve their waste management problem. To collect data in the vegetable zone specifically on the knowledge attitude and practices of the traders in relation to the existing pattern of solid waste collection, transportation and waste disposal To suggest policy measures in maintaining an environmentally sustainable market, so that the experience from this study can be discouraged and stored to other markets in Nigeria. To organize the vegetable traders to identify and solve solid waste problems which involves collection, transportation of disposal of solid wastes.
Key findings	Need for environmental education should be vigorously pursued. Different containers are used to store wastes before disposal, this range from polythene bags to baskets, straw bags and metal bowls Traders had a negative attitude towards sorting of waste before disposal at the pre-intervention phase as waste was considered to be bad, worthless with no advantage, not to be touched and can be a source of contacting diseases. Traders had a negative attitude towards paying for and participating in effective solid waste management The knowledge of the traders in the vegetable zone on the association between solid waste and pests, diseases and environmental sanitation at the pre-intervention phase was quite high.
Main recommendations	In the foodstuff section of Bodija market, the use of baskets and metal bowls as standard containers for waste collection should be encouraged by the association Use weekly meetings as channels for disseminating information

	on the disadvantages of littering the market places and advantage of community participation in solid waste management and the advantages of the compost plant located in the market. The traders association needs to educate their members on market sanitation and sorting of waste before disposal Fines should be collected from anybody found littering the market place Federal Ministry of Education should develop a curriculum on waste management in primary and secondary schools.
Researchers	Oyewo Oyelayo Abike, Prof. M.K.C Sridhar (supervisor), Dr. I.O. Olaseha (supervisor)
Year	2001
Title of project (4)	Effects of Training and Provision of collection bin on source-separation of solid wastes among workers of the University of Ibadan
Research type	Masters of Public Health
Institution/Department	Faculty of public Health, department of Epidemiology, medical statistics and environmental health, College of Medicine, University of Ibadan
Objectives	To characterize the solid wastes generated in the non-residential areas of the University of Ibadan and assess the effects of training and provision of the fabricated bin on the adoption of source-separation as a waste management strategy among selected University of Ibadan non-residential communities. To characterize the solid wastes generated in the selected areas (non-residential communities) into physical and chemical components so as to identify their recyclable potentials. To obtain baseline information on the present waste management practices and institutional arrangement on solid waste disposal on campus. Introduce source-separation of waste among the wastes generators and collectors in selected communities of the University. Assess the effects of training and the designed, fabricated 75kg capacity waste bin with three compartments on the adoption of source-separation among workers at the University of Ibadan.
Key findings	The institutional solid waste management practice in place at three locations. The campus waste bins was utilized by majority of workers as the method of waste disposal at the three locations and most of the bins were also used without covers; while some were perforated and burnt. The major components of solid waste were plastics, paper, and food waste, metal and wood. The present institutional solid waste management was not very effective as there were some lapses especially in collection and disposal of the wastes generated.

	The knowledge, attitude and practice of the workers towards source-separation of solid waste were very low at baseline. Some recycling activities on campus especially among the university contracted cleaners were observed even though at low scale
Main Recommendations	There should be mass production of the multi-compartment wastes bin to encourage the adoption of source separation of waste as a waste management strategy Public Environmental Awareness programs and education should be conducted on campus periodically Environmental corps should be inaugurated to enforce sanitation rules and regulations on the campus. A solid waste recycling plant should be established on the campus. A waste management committee should be inaugurated on campus to monitor recycling activities on campus.
Researchers	Elemile Olugbenga, Prof M.K.C. Sridhar (supervisor), Dr. G.R.E.E. Ana (supervisor)
Year	2009
Project title (5)	Community Attitudes and Practices regarding refuse generation and disposal in Mushin and Agege local Govt. Area Lagos State.
Research Type	Masters of Public Health
Institution/department	Faculty of public Health, department of Epidemiology, medical statistics and environmental health, College of Medicine, University of Ibadan
Objectives	To learn how citizens in the two local council areas perceive the refuse problem in their areas and what actions they do currently and would be willing to take in the future to abate the health and environmental hazards posed by indiscriminate disposal.
Key findings	The most common components of their refuse were paper and nylon bags, in contrast to a greater proportion of organic wastes found in rural communities. Knowledge about the health problems associated with refuse was relatively low Attitudes favouring personal and community responsibility in controlling the refuse problem were significantly higher in Agege than Mushin Although sanitation activities are done weekly and monthly, respondents of this survey were not found to be very knowledgeable about the hazards associated with refused nor highly motivated in their locales.
Main Recommendations	Health education to increase people's knowledge and perceived threat from improper refuse disposal is required Government effort to control the refuse problem should focus on community participation from the planning through implementation and evaluation stages
Researchers	Akinlabi Jimoh, William Brieger (supervisor)
Year	2000

Title of project (6)	An assessment of solid waste management options in Abuja (FCT) Nigeria
Research type	Masters of Public Health
Department	Faculty of public Health, department of Epidemiology, medical statistics and environmental health, College of Medicine, University of Ibadan
Objectives	The study views the solid waste management options in Abuja Nigeria.
Key findings	Only 28.7% of Abuja residents use refuse bins provided by primary waste collectors as every available space is turned into refuse dumps. Harbourage for vectors of diseases, breeding ground for disease agents.
Recommendations	Zoning of Abuja should be done for the purpose of waste collection and final disposal Private waste collectors should be assigned to cover specified areas for collection and disposals. Municipal waste collection must involve the individual, community members, private waste operators, LGA officials and officials of other tiers of government. Private waste collectors with franchise for waste collection for any area must meet a minimum standard in terms of equipment, personnel and technical skill to handle the type of waste
Researcher	Segilola Araoye
Year	2005
Title of project (7)	Potential Human Health Effects of Landfill sites
Research type	Masters of Public Health
Department	Faculty of public Health, department of Epidemiology, medical statistics and environmental health, College of Medicine, University of Ibadan
Objectives	To identify potential human health effects associated with landfill sites
Key findings	In Nigeria, the propensity of residents to generate waste seems to have heightened in recent times. Landfilling and/or open dumping of wastes are common methods of managing wastes. Migration of landfill gas through soil was likely. Presence of large quantities of mixtures of potentially hazardous chemicals in landfill sites close to residential populations have increased.
Recommendations	There is need for further research into the health effects of landfill sites is relatively immature.
Researcher	Ojo Mofoluke Modupe
Year	2008

Project title (8)	Development of an Organo-Mineral Fertilizer Processing Plant
Research type	Ph.D. Thesis
Institution/department	Mechanical Engineering Department, Faculty of Technology, University of Ibadan, Ibadan, Nigeria.
Objectives	To development an appropriate, sustainable and indigenous technology for recycling of market refuse and abattoir waste into organic based fertilizer in Nigeria
Key findings	Indigenous processing technology for conversion of solid waste to organic-based fertilizer in both powdered and pelletized forms was developed. A ten (10) tons/day capacity commercial scale organic fertilizer processing plant was design, installed and tested. About 30 to 50 tons of market refuse and abattoir are processed daily into organic fertilizer. The basic unit operations of the plant are: collection and transportation, sorting, shredding, composting, curing, drying, screening, pulverising, mixing and fortification, pelleting, and bagging. The seven major unit operations including: shredding, drying, screening, pulverizing, mixing, pelletizing and bagging were mechanised. The required machines: shredder, dryer, sorter, pulveriser, mixer, pelletiser, and bagger were designed and fabricated using locally sourced materials.
Main recommendations	Based on this developed technology, seven (7) commercial plants with different production capacities have been developed, installed and currently in operation in different parts of the country: (1)The UI/RMRDC Organic-mineral Fertilizer Demonstration Plant at the University of Ibadan. Sponsored by the Raw Material Research and Development Council (RMRDC), Abuja. (2)The Sorting Centre/Organic Fertilizer Plant at Ayeye Community, Ibadan, Oyo State. Sponsored by UNICEF. (3)The Food waste Composting Plant at Forcados, Delta State. Sponsored by Shell Petroleum Development Corporation (SPDC). (4)The Pace Setter Integrated Waste Management Plant at Orita-Aperin, Ibadan, Oyo State. The second plant sponsored by the Oyo State Government. (5)The Sunrise Integrated Waste Management Plant at Akure, Ondo State. Sponsored by the Ondo State Government. (6)The Plastic/Nylon Recycling and Composting Plant at Aleshinloye Market, Ibadan, Oyo State. Sponsored by MTN Foundation. (7)The Solid Waste Composting Plant at Minna, Niger State.

	Sponsored by UNDP.
Researchers	Dr. Fadare, D.A. [e-mail:fadareda@yahoo.com] and Professor Bamiro, O.A.(Supervisor) [oa.bamiro@mail.ui.edu.ng]
Year	2006
Publications	1. Fadare, D.A., Bamiro, O.A. and Oni, A.O. (2010) "Energy and Cost Analysis of Organic Fertilizer Production in Nigeria" Energy, 35(1):332-340. 2. Fadare, D.A., Bamiro, O.A. and Oni, A.O. (2009) "Energy Analysis for Production of Powdered and Pelletised Organic Fertilizer in Nigeria" ARPN Journal of Engineering and Applied Sciences, 4(4):75-82. 3. Sridhar, M.K.C., Adeoye, G.O., Fadare, D. A. and Bamiro, O.A. [2006] *"Organic and organo-mineral fertilizer from wastes"* Patent of Federal Republic of Nigeria No. RP: 16646. 4. Fadare, D.A., Bamiro, A.O. Adeoye, G.O., Sridhar M.K.C. [2008] *"Development of indigenous manufacturing infrastructure in Nigeria: a case study of the Pace-setter organic fertilizer plant"* Proceedings of the 21st Nigerian Institution of Mechanical Engineers Conference (WARRI 2008), 20-22nd of October, 2008, Warri, Delta State, Nigeria, pp. 95 - 100. 5. Fadare, D.A., Bamiro, O.A. and Oni, A.O. [2009] *"Energy analysis of an organic fertilizer plant in Ibadan, Nigeria"* Journal of Research in Engineering, 6(2):112-120. (Nigeria).

2.15. Summary

Eleven out of the twenty consortium members submitted reports on research within their respective organisations related to solid waste management. Whiles some of the reports consisted of pure academic research leading to the award of academic degrees others were concrete projects carried out in several countries. Majority of the reports were basic research involving data gathering and analysis. Others did not only focus on data acquisition but also technology transfer leading to the actual implementation of the project.

Quite a number of the research within the consortium focused on composting. Basic questions like improving compost efficiency by varying temperature and aeration have been considered. Also, co-composting of municipal waste and faecal matter (dewatered) has also engaged the attention of researchers. Aside this, ground breaking research on addressing the issue of greenhouse gases emission through composting was also tackled by researches within the consortium. The development of processing technology for the conversion of solid waste into organic fertilizer in powered and pelletized forms has been championed by one of the consortium members. This has led to the establishment of seven (7) commercial plants with different production capacities currently producing powdered and pelletized compost for the general public. Organic waste management as part of an integrated waste management system has also been investigated. A technical aspect of the research is improved technologies for food waste composting.

One other area that has received attention from consortium members is the problem of electronic waste (e-waste). Three consortium members namely EMPA, IAGU and BCRC have collaborated in carrying out extensive country studies of the e-waste menace in Ghana, Senegal, Uganda, Nigeria, Uganda, Ethiopia and South Africa. The country reports maps out the e-waste problem and provide information on sources, disposal methods, crude recovery of useful materials, and policy options and recommendations.

Other administrative problems such as scheduling of waste collection trucks, institutional arrangement for private waste collectors, waste management options and assessment of waste collectors have received attention from researchers within the consortium. Aside this some researchers have also looked at source separation through education and training of a selected number of people in a chosen community as a potential waste management option.

Other researches carried out include pollution of water underground water bodies in areas where landfills are located. Also, leachate from dumpsites and the quality of the topsoil in dumpsites have been investigated. Human Health effect of landfills has also received attention from researchers. Waste management of garages itinerants has also been researched into with interesting findings.

3. CURRENT RESEARCH OUTSIDE OF CONSORTIUM IN TARGETED REGIONS

3.1. Nigeria

In Nigeria, research into waste management has been primarily carried out by institutions of higher learning. Areas covered include waste characterisation, waste management, disposal options and recycling of waste. Lists of institutions outside of the consortium conducting research in waste management in Nigeria are provided in the tables below.

Name of research centre (1)	**University of Nigeria, Nsukka, Nigeria**
Country	Nigeria
Department	Department of Geography, Waste Management & Recycling Research Unit,
Contact person	Thaddeus Chidi Nzeadibe
Email	chidinzeadibe@yahoo.com
Title of project	Solid waste reforms and informal recycling in Enugu urban area, Nigeria
Objectives	To examines the position of the informal recycling sector in the planning and reform of solid waste management in the city of Enugu, Nigeria
Short description	The study highlights recent efforts to visibly improve governance through reform of solid waste management in the urban area. It notes the contribution of informal recyclers towards handling the city's solid waste problem in the areas of job creation and poverty alleviation. The study also reveals that the import of the informal recycling sector has not been given adequate consideration within the framework of the reforms in solid waste management and with the focus of the Millennium Development Goals on poverty reduction, improvement of quality of life and environmental sustainability. The research was based on direct field observations, key-informant interviews with important stakeholders in solid waste management in Enugu, and review of relevant legislation, policy documents and reports on solid waste management.
Key findings	The informal recycling sector is making significant but unacknowledged contribution towards the economy and environment of Enugu. The activities of the informal recycling sector in Enugu could contribute towards attainment of the MDGs particularly those related to poverty reduction, job creation and environmental sustainability. The activities if not given policy and practical support, could also retard achievement of the MDGs related to sanitation, malaria and other diseases
Publications	Nzeadibe, T.C (2009). Solid waste reforms and informal recycling in Enugu urban area, Nigeria. Habitat International 33: 93–99.
Name of research center (2)	**Bells University of Technology, Ota, Ogun State, Nigeria**.
Country	Nigeria
Department	Department of Chemical Sciences,
Contact person	Babayemi, J. O.
Email	babayemola@yahoo.co.uk.
Title of project	Evaluation of Solid Waste Generation, Categories and Disposal Options in Developing Countries: A Case Study of Nigeria

Objectives	The study investigates the quantity and rate of solid waste generation in several cities in Nigeria, factors influencing the generation, solid waste types and categories, collection, disposal, reuse and recycling, and environmental problems.
Short description	The study evaluated the common solid waste disposal options, the level of awareness on waste management; the effect of Gender, age and educational status on solid waste management and reasons for not using an appropriate waste collection service in traditional cities in Nigeria, taking Abeokuta as a case study. Extensive literature search, administering of questionnaires, interview and personal observation were employed. Questionnaires were administered, covering the major parts of Abeokuta.
Key findings	The results indicated large generation at high rate without a corresponding efficient technology to manage the wastes. Of 201 respondents to questionnaire in Abeokuta, 35.8% used waste collection services, 64.2% used other waste disposal options, 16.4% used both, 68.7% and 58.7% were aware of waste collection service and waste management regulations, respectively; while 28.4% separated their solid wastes at source. Though the level of awareness of waste collection services and waste management regulations were relatively high in Abeokuta, the percentage of those who used other indiscriminate solid waste disposal methods like open dumping, open burning, and dumping in drainages was higher. Educational status, age, gender, cost of waste collection services and the location of residence, among others, were factors influencing solid waste management in Abeokuta. The quantity and the rate of solid wastes generation in Nigeria have outgrown the capacity of nature to naturally absorb them.
Publications	Babayemi, J. O.; Dauda, K. T (2009). Evaluation of Solid Waste Generation, Categories and Disposal Options in Developing Countries: A Case Study of Nigeria. J. Appl. Sci. Environ. Manage Vol. 13(3) 83 – 88
Name of research center (3)	**Yaba College of Technology, Lagos, Nigeria. University of Lagos, Nigeria.**
Country	Nigeria
Department	1. Chemical Science Department, School of Science, Yaba College of Technology, Lagos, Nigeria. 2. Chemistry Department, Faculty of Science, University of Lagos, Nigeria.
Contact person	Oyelola, O.T
Email	ibitoniola@yahoo.co.uk
Title of project	Characterization of domestic and market solid wastes at source in Lagos metropolis, Lagos, Nigeria
Objectives	To estimate the percentage of various components of household and market waste generated from source and also the seasonal

	composition of household waste IN Lagos metropolis.
Short description	Proper characterization of municipal solid waste is fundamental for the planning of municipal waste management services. The domestic and market solid wastes generated during a period of 48 days by a sampling of 200 households and 40 market waste samples of different socio -economic characteristics were classified and weighed at source between March 2004 and April 2006.
Key findings	Results of domestic and market solid wastes generated during a period of 48 days by a sampling of 200 households and 40 market waste samples of different socio-economic characteristics. The household solid waste mainly consisted of putrescible waste (68.16%), paper (12.46%), nylon (7.68%), Plastic (3.64%), glass (1.78%), metal (2.08%), and garden waste/grit (4.20%). The market waste consisted of putrescible waste (68.98%); paper (23.57%), nylon (3.92%), Plastic (1.77%) and metal (1.77%). The seasonal composition shows a high generation of putrescible during the wet season and nylon during the dry season.
Publications	Oyelola, O. T; Babatunde, A. (2008). Characterization of domestic and market solid wastes at source in Lagos metropolis, Lagos, Nigeria. African Journal of Environmental Science and Technology Vol. 3 (12), pp. 430-437.
Name of research center (4)	**University of Abuja, Abuja, Nigeria**
Country	Nigeria
Department	Department of Civil Engineering.
Contact person	Ogwueleka, T.CH
Email	*ogwueleka@yahoo.co.uk*
Title of project	Municipal solid waste characteristics and management in Nigeria
Objectives	To examine current solid waste management practices and problems in Nigeria. The specific aims are the following: -to present the current state of municipal solid waste in Nigeria, and the challenges it faces. -to document solid waste problems in Nigeria. -to recommend and discuss applicable solutions to the solid waste management system.
Short description	Nine cities, Lagos, Maiduguri, Kano, Ibadan, Makurdi, Port-Harcourt, Onitsha, Nsukka, Abuja were chosen as urban representatives of the current solid waste management in Nigeria. This was based on the existing situation with different waste management problems, size, and challenges. The study was undertaken from April to October, 2007 and carried out in three steps. Step 1: Documents, records and academic literature relating to municipal solid waste management in Nigeria were studied. Step 2: Thirty six (36) state environmental agencies workers

	involved in municipal solid waste management were interviewed to update information in the document and records collected. Step 3: Twenty dump sites were visited at Abuja, Makurdi, Lagos, Nsukka, Onitsha, Port-Harcourt, Kano. Also the residents, scavengers, private contractors were interviewed to confirm the collection, disposal and treatment procedures, recycling practice and problems facing solid waste management.
Key findings	Solid waste management in Nigeria is characterized by inefficient collection methods, insufficient coverage of the collection system and improper disposal. The waste density ranged from 280 to 370 kg/m^3 and the waste generation rates ranged from 0.44 to 0.66 kg/capita/day. The common constraints faced by environmental agencies include lack of institutional arrangement, insufficient financial resources, absence of bylaws and standards, inflexible work schedules, insufficient information on quantity and composition of waste, and inappropriate technology.
Publications	Ogwueleka, T.C (2009). Municipal solid waste characteristics and management in Nigeria. Iran J. Environ. Health. Sci. Eng., 2009, Vol. 6, No. 3, pp. 173-180
Name of research center (5)	**Kano University of Science and Technology, Wudil, Kano State, Nigeria**
Country	Nigeria
Department	Department of Geography
Contact person	Aliyu Baba Nabegu
Email	marpelione@hotmail.com
Title of project	An Analysis of Municipal Solid Waste in Kano Metropolis, Nigeria
Objectives	To provide data on the composition, and sources of municipal waste in three different zones of Kano city for the purpose of understanding the type of waste generated, waste flow and implication for solid waste management in Kano state. To address the apparent gap in information that is crucial for successful management, to understand the practice and identify the lacunae.
Short description	Municipal solid waste analysis was undertaken in Kano metropolis through the collection of secondary data from the government agency (Refuse Management and Sanitation Board, REMASAB) responsible for the management of solid waste, interviews with stakeholders and field surveys.
Key findings	The household sector in Kano metropolis produces the largest amount of waste in the city accounting for 62.5% and the waste generated by various institutions in Kano accounts for only 5.8%, while industries located within residential areas contributed 2.9%. It is estimated that Kano metropolis generates about 3085 tonnes of solid waste per day. It is also found that Kano metropolis's solid waste consists to a large extent of organic and other biodegradable matter (43%) and constitutes 68.26% by weight of

	solid waste generated in the study area. The results indicate that that solid waste is not properly managed since there is no ideal landfill and recycling is limited. Due to poor management, the waste emits dangerous gases into the atmosphere and bacterial isolates were recovered from the waste sample, three of which were *coliform* bacterial (*E. coli, Klebsielle sp and Shigella sp.).*
Publications	Aliyu Baba Nabegu (2010). An Analysis of Municipal Solid Waste in Kano Metropolis, Nigeria: J Hum Ecol, 31(2): 111-119
Name of research center (6)	**University of Technology, Thonburi, Thailand**
Country	Thailand
Department	Environment Division, Joint Graduate School of Energy and Environment.
Contact person	Kofoworola, O.F
Email	sholafemi28@yahoo.com, okofoworola@hotmail.com
Title of project	Recovery and recycling practices in municipal solid waste management in Lagos, Nigeria
Objectives	To examine the status of recovery and recycling in current waste management practice in Lagos, Nigeria. To review existing recovery and recycling patterns; recovery and recycling technologies, approaches to materials recycling, and the types of materials recovered from MSW so that there is a reduction in the quantity of recoverable materials in residential and commercial waste streams to minimize the problem of MSW disposal.
Short description	The management of urban MSW is a big problem in cities because of the lack of sufficient equipment to collect the waste. The situation is not different in Lagos, Nigeria. Information for this study was mainly through literature review.
Key findings	Lagos does not have an integrated waste management plan. Presently, only paper, plastics, glass and metals, have high market values in Lagos. These are separated from wastes either at the source or at dumpsites sites by scavengers and then sold to the market.
Publications	Kofoworola, O.F (2007). Recovery and recycling practices in municipal solid waste management in Lagos, Nigeria. Waste Management 27 (2007) 1139–1143
Name of research center (7)	**Sheda Science and Technology Complex.**
Country	Nigeria
Department	Biotechnology Advanced Laboratory
Contact person	Dr. Shola Odusanya
Email	odusanya@shestco.org
Title of project	

Objectives	To solve the waste menace of plastic waste. The project will become marketable and will create new jobs. Litter bins for plastic waste will be set up nationwide, and people will be recruited to search through the dumps for plastics.
Short description	To manufacture biodegradable plastic bags. Researchers are working to embed biodegradable starch in polymers, which are used to make plastics. Next, they identify microbes that would feed on the starch and cause it to break down completely into organic material, which would then be assimilated back into the soil. The process involves using some proprietary solvents that is being kept secret because it is a potentially very big commercial project. One of the uses of this is water-repellent paint.
Key findings	On-going
Publications	Not known, information sourced from www.voanews.com "Nigeria's plastic bag dilemma"
Name of research centre (8)	University of Abuja, Abuja, Nigeria
Country	Nigeria
Department	Department of Civil Engineering
Contact person	T. Ch. Ogwueleka
Email	
Title of project	Municipal solid waste characteristics and management in Nigeria
Objectives	This paper aims to examine current solid waste management practices and problems in Nigeria. To present the current state of municipal solid waste in Nigeria, and the challenges it faces. To document solid waste problems in Nigeria. To recommend and discuss applicable solutions to the solid waste management system.
Short description	Municipal solid waste management has emerged as one of the greatest challenges facing environmental protection agencies in developing countries. This study presents the current solid waste management practices and problems in Nigeria. Solid waste management is characterized by inefficient collection methods, insufficient coverage of the collection system and improper disposal. The common constraints faced environmental agencies include lack of institutional arrangement, insufficient financial resources, absence of bylaws and standards, inflexible work schedules, insufficient information on quantity and composition of waste, and inappropriate technology. The study suggested study of institutional, political, social, financial, economic and technical aspects of municipal solid waste management in order to achieve sustainable and effective solid waste management in Nigeria.
Key findings	Waste generation rates and breakdown density for urban and rural areas were obtained. The solid waste collection efficiency in Nigeria ranged from 5

	percent in some semi-urban areas to 50 percent in urban areas. Open dumping of waste cannot be considered as a long-term environmental method of disposal. Vehicles used are obsolete and too expensive to operate and maintain. The containers are old and too few.
Publications	Iran. J. Environ. Health. Sci. Eng., 2009, Vol. 6, No. 3, pp. 173-180 173
Key findings	Waste generation rates and breakdown density for urban and rural areas were obtained. The solid waste collection efficiency in Nigeria ranged from 5 percent in some semi-urban areas to 50 percent in urban areas. Open dumping of waste cannot be considered as a long-term environmental method of disposal. Vehicles used are obsolete and too expensive to operate and maintain. The containers are old and too few.
Publications	Iran. J. Environ. Health. Sci. Eng., 2009, Vol. 6, No. 3, pp. 173-180 173
Name of research centre (9)	Cranfield University, Bedfordshire MK43 OAL, UK
Country	England
Department	Department of Applied Energy, School of Mechanical Engineering
Contact person	E. Daskalopoulos, O. Badr & S. D. Probert
Email	
Title of project	Economic and Environmental Evaluations of Waste Treatment and Disposal Technologies for Municipal Solid Waste
Objectives	To categorize the waste fractions obtained To recommend ways of disposing wastes To convert putrescible organic material to a stabilized form and to destroy organisms pathogenic to humans. To check that the control measures adopted remain effective and to identify any loss in efficiency in the control system. To reviews the main economic costs and the environmental impacts of the widely-accepted waste treatment and disposal methods.
Short description	The disposal of MSW has been the focus of environmental policy for several industrialised countries since the mid-1970s, when attempts were made to identify and categorise, in a systematic way, the waste fractions involved. This paper reviews the main economic costs and the environmental impacts of the widely-accepted waste treatment and disposal methods.
Key findings	Recycling is an alternative waste-treatment technology with acknowledged environmental benefits. A change in the waste- management policy, combined with a transformation of the consumption patterns is considered to be vital for the success of recycling initiatives.
Publications	Applied Energy, Vol. 58, No. 4, pp. 209-255, 1997

3.2. Ghana

Research into waste management has been primarily carried out by researchers from mainly the public universities with very little or no funding. Quite a few are able to secure external support for their work. A few Non-governmental Agencies with strong foreign partners have also conducted some research into specialized areas such as E-waste in Ghana. Some Metropolitan Assemblies like KMA collaborate with some foreign universities by providing their researchers with primary data. Even though they have a research department not much has been done in terms of primary research into Integrated Waste Management Systems. The Environmental Protection Agency is also known to collate data on industrial waste in Ghana. Results of such research are not published for public consumption.

Name of Research Centre	University of Ghana
Country	Ghana
Department	Department of Environmental Science
Contact person	Alexander Mintah Afful
Email	
Title of project	Solid Waste Management in the Tema Municipality
Objectives	To assess the problem involved in collection, storage, transportation, processing and disposal of solid waste. To know the methods of managing the risks to the environment, health and safety of general public and the personnel involved in collection and disposal of solid waste in the Tema Metropolitan Assembly
Short description	
Key findings	Higher income earners have storage facilities, greatest awareness and limited indiscriminate disposal. Low income earners use different device for storage (wooden box, drums, plastic and metal bens with lids) Over 60% waste stream was organic. No waste separation and awareness programs. Adequate legal framework to regulate solid waste management but lack of implementation.
Year	2009
Publications	Non
Project Title (2)	Nitrogen enrichment of recycled organic waste for peri-urban maize (Zea Mays L.) cultivation and its effects on the soil environment
Research type	PhD in Environmental Science
Institution	Faculty of Sciences, University of Ghana, Legon
Objectives	The main aim of this study was therefore to improve on soil and crop productivity in the urban and per-urban areas through the use of N-enriched co-compost (Comlizer)
Key findings	The study revealed that the use of urea or ammonium sulphate in enriching co-compost reduced faecal coliforms and helminth eggs, thus sanitizing the comlizer and making it safe for use.

	The results of the experiment showed that net cumulative N released (NCNR) to soil treated with ammonium sulphate alone amounted to 67 % of the total N applied, and was thus higher and significantly different from that of soil treated with urea alone. The results showed that transpiration efficiency (TE) of maize was dependant on the growth stage and at the vegetative phase, TE increased with increase in N application rate for fast nutrient releasing fertilizers (DFS, Eco, EC, NPK + $(NH4)_2$ SO_4, $(NH4)_2$ SO_4) while at the reproductive phase, TE was high for slow nutrient releasing fertilizers (C and Co). The result showed that C, Co, Eco, and DFS increased growth, yield components of maize as N application rate increased 91 to 210 kg N ha -1. The results showed that, C, Co, DFS EC, ECo and organic fertilizers increased nutrient uptake, nitrogen (N) and phosphorus (P) use efficiency by the maize and also both sol residual mineral-N and available P. The results showed that the nitrate concentration of NPK + $(NH4)_2$ SO_4 DFS EC and Eco treated soil 3 days after application were significantly higher than the non enriched Co and C suggesting that movement beyond the plough layer, should moisture content exceed that at field capacity, will be higher in the soils amended with the inorganic fertilizer, enriched compost (EC), enrich (ECo) and DFS than those of the non enriched (C or Co).
Main recommendations	There should be a study to address the effects of N enriched compost or N enriched co-compost on SOM quality and key soil organic carbon pools.
Researcher	Noah Adamtey (Author)
Year	July, 2010

Name of Research Centre	Green Advocacy
Country	Ghana
Contact person	
Email	
Title of project	National Environmental Knowledge Survey of Pre-Tertiary Students
Objectives	Assessing the level of environmental knowledge and consciousness; Determining the contribution of school work/programme to environmental knowledge; Determining the role of text-books in influencing environmental knowledge acquisition; Determining the possible sources of environmental information; Exploring interest in reading regularly about the environment in a newsletter and Assessing possible disparity in environmental knowledge and consciousness between pupils/students in rural and urban schools.
Short description	To understand the scope of understanding and appreciation of

	environmental related issues among the young population of the country it was important to design a research programme to address it. This project was carried out with the support of the Ministry of Education where some basic and secondary schools were selected at random. A questionnaire was administered to students in these areas seeking to find their knowledge about recycling of waste, environmental conservation, climate change, among others.
Key findings	Report is still not ready
Year	2008
Publications	No publication yet
Title of project (2)	SBC E-waste Africa Project
Objectives	Enhancing environmental governance of e-waste Creating favourable social and economic conditions for partnerships and small businesses in the recycling sector in Africa
Short description	E-waste and end-of-life electric and electronic equipment generated locally or imported from other countries remain piled or are burned in open dumpsites in a number of African countries. Entire communities are exposed to this waste which, if not disposed of in a sound manner, can release dangerous substances in the environment and affect the health of local communities living in its vicinity. E-waste contains toxic substances such as lead, cadmium, mercury or brominated flame retardants. But e-waste is also a resource and some of these substances, as well as valuable parts, could be recycled and re-used providing economic opportunities through the development of community based collection, recovery and recycling businesses
Key findings	Project is still running
Year	2009 – 2011
Publications	No publications yet

Name of Research Centre	Council for Scientific and Industrial Research
Country	Ghana
Department	Soil Research Institute /KNUST
Contact Person(s)	Dr. Edward Yeboah/ Dr Moses Mensah
Email Address	mymens14@gmx.com
Title of project	Biochar production from agricultural and industrial waste
Objectives	To develop local technology in decentralized biochar reactors for large scale promotion in farming communities in Ghana To investigate fertilizing properties of biochar from various feedstock's on soil, and on crops yield To ascertain the combined effect of biochar and compost application on the fertility and stability of soils, as well as on crop yields To use biochar production as a medium for achieving sustainable development via jobs creation, improvement in agriculture, reduction in greenhouse gas emissions, and reduction in use and

	importation of inorganic fertilizer
Short description	Research is focussing on producing and characterizing biochar using available local feedstock's such as sawdust, rice husks, maize stovers, cocoa wastes, kitchen waste, and others. Biochar reactors are being designed and constructed for ten agricultural stations in all ten Regions of Ghana.
Key findings	
Year	2010-2012
Publications	Not available

Name of Research Centre	Ghana Statistical Service
Country	Ghana
Contact Person	
Email Address	
Title of project	Population and Housing Census
Objectives	The main objective of the population and housing census is to determine the number of people and households in the country. In addition, the state of waste management both liquid and solid waste are assessed to inform policy direction
Short description	Since no proper records of waste generation and disposal is collected and kept, it is very difficult to determine the percentage of the population who enjoy sound waste management practices like waste collection, how many burn their waste and how many carry out open dumping of their waste on the national scale. Also, socio-economic data for the various regions are collected and analysed.
Key findings	
Publications	Ghana Living Standards Survey (2005) www.statsghana.gov.gh/docfiles/glss5_report.pdf

Name of Research Centre	National Population Council
Contact Person	
Email Address	npcsect@4u.com.gh
Title of project	Population, Water and Sanitation
Objectives	To determine the percentage of population's • main source of drinking water • waste disposal methods • liquid waste disposal methods • access to toilet facilities by type
Short description	Availability of adequate potable water as well as good sanitary conditions is required for good health in any society. In order to illustrate the water and sanitation situation in Ghana, Fact Sheet No. IV presents data on sources of drinking water, disposal of solid and liquid waste, and access to toilet facilities at national, regional and district levels from the 2000 Population and Housing Census. The information presented will assist policy makers and planners at

	various levels to adopt strategies that will address the issues
Key findings	Nationally of the waste generated; • 4.8% is collected • 7.9% is burned • 57.6% is dumped at public dumping grounds • 25% dumped elsewhere • 3.9% buried
Publications	Factsheet 4 http://www.npc.gov.gh/assets/FactSheet4_pop,water&santitation.pdf
Year	2006

Name of Research Centre	Centre for energy, environment and sustainable development (CEESD)
Contact Persons	Edem Bensah, Edward Antwi, Julius Ahiekpor
Email Address	info@ceesdghana.org/ ceesdghana@gmail.com
Title of project	Anaerobic wastewater treatment plant for the treatment of organic waste and wastewater at Kumasi abattoir
Objectives	• To implement a state-of-the-art biogas plant for treatment of organic waste produced at Kumasi abattoir • To map organic solid waste of industries in Kumasi for inclusion as feedstock for the biogas plant at Kumasi abattoir • To develop Project Idea Notes (PIN) and Project Design Document (PDD) for the project • To register the project for carbon funding with UNFCCC • To liaise with investors and interested organizations to implement the biogas plant as a CDM project
Short description	This project is aimed at reducing GHG emissions from the wastewater generated by Kumasi abattoir by replacing the inefficient aerobic wastewater treatment system currently utilized with state-of-the-art anaerobic digesters. Organic waste consisting of cow dung, rumen and intestinal contents, as well as pig, goat, and sheep manure that are currently disposed untreated would also be channelled into the anaerobic treatment system. In addition, dung from cattle pens that are not collected and allowed to mix with the soil, would also be collected and treated in the anaerobic digester. The sludge from the anaerobic plant would be used in co-composting while the wastewater would be further treated in a lagoon. This project is expected to reduce considerably the tonnage of methane (CH4) emitted since methane – that is currently emitted through the current inefficient aerobic treatment systems and the raw disposal of dung, rumen contents, and manure from pigs, goats and sheep – would be captured and combusted. The baseline wastewater treatment system consists of an aeration tank and an open stabilization lagoon. In the baseline scenario, methane is released into the atmosphere from the depths of

	stabilization tanks used. In the project scenario, biogas is generated, combusted in a gas engine generator to produce heat and electricity. Excess gas would be flared. The heat produced would be used to heat the digester in order to increase the rate of anaerobic fermentation of organic matter and thus reduce the retention time. Electricity generated would be fed into the central grid. In order to increase the biogas production, CEESD is mapping organic solid wastes from cocoa processing and brewery companies for inclusion in the future biogas plant.
Key findings	The execution of the project will save about 5,068.88 k tons of carbon dioxide annually culminating in a net savings of 50,688.8 k tons during the crediting period of 10 years. Electric power to be generated is 80.8 Kw and the entire cost of the project is estimated at 1.7 million United States dollars. Apart from the sales of the CERs which is estimated to fetch the project about US$ 55,757 per annum, sales of power, process warm water and compost will bring in additional revenue to the project. At 15 % interest rate the NPV is positive whiles the Internal Rate of Return is about 21.37 % which makes the project viable especially when loans contracted to execute the project is expected to be obtained at about 6 % - 10 % interest rate. The payback period was also found to less than 4 years. The Benefit Cost ratio was found be more than one (1). These financial indicators make the project viable and worthy of implementation.
Publications	PIN has been approved by Ministry of Environment, Science and Technology, the Designated National Authority for Ghana.
Year	2010 – 2012

3.3. Senegal

Project title (1)	Ecological intensification of agro-production systems through waste recycling (ISRAD) Original title in French: *Intensification écologique des systèmes de production agricole par le recyclage des déchets (ISRAD)*
Name of research centre	French research institute on agronomy (CIRAD) as coordinator of the programme. The programme is funded by the French National Agency for Research (ANR).
Country	Senegal. This action-research programme is being implemented simultaneously in the cities of Mahajanga (Madagascar), Versailles (France) and on the island of Réunion (France).
Department	Region of Dakar
Contact person / Email	Yacine Badiane NDOUR, Senegalese Research Institute on Agronomy (ISRA) Tel: 00221 33 849 38 73 Mail: yacine.ndour@ird.sn Moussa N'DIENOR, French National Research Institute on Agronomy / French Research Institute on Development (INRA-IRD) Tel: 0033 (0)1.30.83.72.54 Mail: moussa.n_dienor@agroparistech.fr
Objectives	To elaborate strategies on how to manage organic waste in a sustainable way To analyse the use of organic waste in various contexts. Expected outcomes: Innovative and simple methods of characterize organic waste, to save time and money Models developed or adapted in terms of biophysical processes to manage the flux of organic waste on various scales (field, farm, territory) Indicators on the agronomical performance and on environmental impacts Cartography of the situations where there is an environmental risk Norms and good practices to intensify the use of organic waste in vulnerable ecosystems. Tools and methodology for farmers.
Short description	In the Region of Dakar, vegetable and fruit production is very important is periurban areas. Fertile soils are now being

	overused, and the intensification of urbanisation leads urban farmers to settle on dry soils containing very few fertilizing elements. Water scarcity is a main problem but not the only one. Chemical fertilizers are getting more and more expensive and there is a need to fertilize the soils. For the time being, urban farmers use mainly poultry and horse dung and litter. They used to recycle peanuts shells but peanut production in the area has decreased a lot during the last decades. On M'Beubeuss dumping site, which has been receiving the waste of the region of Dakar since the 70s, the proportion of organic waste is estimated at more than 40% of total waste. There are currently 6 groups composed of 15 persons that produce what is locally called "terreau" on the dumping site. This compost is sold to green areas, stadiums and in flower production farms. It could be used in agriculture. The network of the cities in the region of Dakar "CADAK/CAR" aims at minimizing waste at the source. There is currently a pilot composting projet of domestic waste in the City of Hann Bel-Air. This pilot project could later be replicated at a larger scale.
Key findings	The programme started in 2009. A mid-term seminar was held in Dakar in December 2010. In Dakar, the flux of organic waste and their use in agriculture have been studied, quantified as far as possible, and a cartography has been produced. Some presentations can be downloaded here: http://isard.cirad.fr/le_projet_isard/agenda_avancement/seminaire_a_mi_parcours_dakar_decembre_2010
Publications	No publications so far.
Project title (2)	Management and Valorization of Electronic and Computer Wastes in West Africa (Bénin, Mali, Sénégal)
Name of research centre	University of Dakar (UCAD) The project is funded by the Canadian Cooperation (International Research Institute for Development and Cooperation – IRDC).
Country	Senegal
Department	--
Contact person	Mr. Cheikh Diop, environnemental chemist, Teacher at the Institut des Sciences de l'Environnement, Faculté des Sciences et Techniques, Cheikh Anta Diop University, Dakar

Email	--
Objectives	This project will examine the issue of electronic and computer waste and its management, and endeavor to identify feasible and sustainable strategies for valorizing such waste.
Short description	*[abstract from the website of IRDC]* Because of their undeveloped condition, African countries receive tonnes of second-hand computers and electronic equipment from more advanced countries. More and more voices are calling for legislative and regulatory provisions to deal with the electronic and computer waste thus generated. So far, little is known about the extent of the problem and there is little research available to serve as a basis for persuading decision-makers to address it. The project will be carried out in Bénin, Mali and Sénégal by a team that includes junior researchers. It is expected that the involvement of young researchers will not only serve to build research capacity but also to maintain research momentum in this area.
Key findings	The project team : carried out an institutional analysis on the Basel Convention, the Bamako Convention, etc. sensitized decision makers and scientists to the issue of e-waste. acquired knowledge on the phenomenon, the life cycle of computers and traceability issues. suggested evolutions of the legislation and a common legislation at the regional or sub-regional level. described how to best benefit from e-waste in terms of job creation.
Publications	--

3.4. Ivory Coast

Project Title (1)	A city meet its waste: A Geographic pollution issues in Abidjan (Côte d'Ivoire)
Search Type	Doctoral thesis
Institution / Faculty	Laval University, Faculty of Geography,
Objectives	Contributing to the management of urban solid waste in Abidjan
Main Results	• The quantity of waste generated by the city Varies with annual growth rate of 4% in Abidjan. The ratio of the average waste quantity per capita is 1.04 kg/ person/ day. • Solid wastes are made of 66.43% from biodegradable materials, recyclable materials of 18.04% and 15.51% of inert materials as sand and pebbles. • Content from the trash varies depending on the level of living areas of

	habitat and activities
Main recommendations	
Researchers	Youssouph Sane
Publications	
Project Title (4)	Sanitation and Solid Waste Management in Abobo (v2): Cases of Abobo-Baoule
Search Type	Master of Geography: Option: Environmental Management
Institution / Faculty	Tropical Institute of Geography / University of Cocody, Abidjan, Cote d'Ivoire
Objectives	Evaluate the production of household waste, wastewater and stormwater in Abobo Baoule-(Abidjan).
Main Outputs	Disposal of domestic waste is a business of Women and Children on 3609 households of the village less than 500 only Subscribed to the service of waste collection. The production of waste in Abobo Baoulé represents 1% of the total production of the town of Abobo. The average ratio of household waste quantity is 1.03 kg/hbt in Abobo-Baoule At the level of Abobo-Baoule, the collection of 16,223 tons / day (Scheduled production ration of the village) costs 48,669 CFA francs or 1,460,070 monthly
Main recommendations	Proposing strategies for clean up and safe the living environment and reduce the risk of environmental diseases.
Researchers	Souleymane Diabagaté
Year	
Project Title (2)	Solid Waste Management in the District of Abidjan (South of Côte d'Ivoire):to GIS Methods and multi criteria analysis
Search Type	Diploma of Graduated Studies
Institution / Faculty	University Department in Earth and Mineral Resources / University of Cocody, Abidjan, Cote d'Ivoire
Objectives	elaborate a guide for the Authority in making choice for the site of future Landfill site in the district of Abidjan from existing data
Main outputs	This study permitted to map the sites most suitable for household waste storage facilities Based on five scenarios developed. A linear combination of these scenarios was carried out in order to reach the most appropriate sites. Sites classified as impaired are areas that represent the areas of extension of the town of Anyama and PK 18 district of the town of Abobo The sites listed good are ones that might be explored to determine the Best Site for installation of household Waste Landfill. They are all located between the town Anyama and the village Anyama Akoupé
Main recommendations	
Researchers	Kan KOUAME jean (jeankan05@yahoo.fr .) DEH SK, Anani AT JOURDA JP, J. BIEM
Year	2007
Project Title (3)	Revaluation of Solid and Plastic Wastes in the industrial zone of Yopougon

	(Abidjan, Cote d'Ivoire) and associated health risks (diseases)
Search Type	Special Master
Institution / Faculty	Swiss Center for Scientific Research in Côte d'Ivoire (CSRS), Abidjan, Cote d'Ivoire
Objectives	Describe the chain of plastic wastes valorization and associated health risks Assess Health Problems met by the workers on the site of the industrial zone of Yopougon
Main Results	• Six categories of actors involved in the process of revalorization of Plastics Waste: salvage dealer –Intermediate wholesalers- cleaners of plastic bags, intermediate dealers-manufacturers. • Plastic Waste Rigid and flexible are two main types of solid waste plastics revalorized in the industrial area of Yopougon • The bags (hard plastic) are sold between 250F and 300F CFA per kg • The bags (soft plastic) are sold at 125 CFA • The sale of plastic waste interest more than 600 actors have almost 300 are on the permanent site of the industrial zone of Yopougon.
Main recommendations	
Researchers	Betio Silué, Brama Koné, Betsi NA, J. Cisse G. Weth
Publications	Science & Technology Vol 15 South
Project Title (4)	Exposure to Environmental Waste containing mercaptan, aromatic hydrocarbons and hydrogen sulfide (Abidjan)
Search Type	Master.
Institution / Faculty	Swiss Center for Scientific Research in Côte d'Ivoire (CSRS), Abidjan, Cote d'Ivoire
Objectives	Provide information on environmental scientific characteristics and dynamics of Toxic Waste in Ivory Coast.
Main Results	Toxic waste from 16 sites were identified in the city of Abidjan. dumped were mainly In the slums and neighborhoods of Abidjan. The town of Abobo in the northern city received most routes, almost 8 sites were identified . Epidemiological Survey reveals a total of 532 people, representing 21.11% of people poisoned by Toxic waste
Main recommendations	Toxic waste sites in Abidjan must be subject to an individual tracking in term of Assessment for Possible contamination of groundwater, the Food Chain and the Long-Term Effects on People intoxicated.
Researchers	KOUASSI DONGO A, JEAN BLAISE KONE, Issiaka TIEMBRÉ BIEM JACOB CISSE Gueladio, Marcel Tanner Zinsstag
Publications	Environment, Isques R & S previous Vol. 8, No. 6, November-December 2009
Year	2009
Project Title (5)	Analysis of deficiencies in the management of urban drainage and solid waste and liquid in the shantytowns of Yopougon (Abidjan, Cote d'Ivoire): Approach-sig mapping, modeling and anthropology
Search Type	Doctoral thesis
Institution / Faculty	University Department in Earth and Mineral Resources / University of Cocody,

	Abidjan, Cote d'Ivoire
Objectives	• contribute to attenuation of the syndrome from the poor management of urban drainage and solid waste and liquid in the shantytowns of Abidjan (Ivory Coast) • analyze the present state of sanitation system and its relationship with the Environmental Factors in area of study; • Assess perceptions and behavior of actors in the sector and populations in the management of solid and liquid wastes • Provide innovative solutions for mitigating syndromes Related to Sanitation in these disadvantaged environments in order to improve their Sanitary conditions
Main Results	• Majority of the solid and liquid waste products are not collected and invade the streets, vacant lots and storefronts concessions. • Informal settlements remain underserved by the pre-collectors despite the help of the public service because of problems of access, non appropriate approach and lack of priority by the Government.
Main recommendations	
Researchers	Kouassi Dongo
Publications	
Project Title (5)	Waste Management in Abidjan: A recurring problem seems unresolved
Search Type	Scientific Publication
Institution / Faculty	
Objectives	
Main Results	The MSW generated in Abidjan include: what is traditionally called the "garbage", they are from households or shops, handicrafts, small enterprises; Waste products from larger and less so everyday furniture, appliances large and small vehicles and tires, construction waste, demolition and alteration of buildings; wastes that require special measures because of the immediate dangers they pose to the safety of people and the environment: waste sector health, special waste subject to special legislation The waste from the city of Abidjan are comprised 66.43% of biodegradable materials, recyclable materials 18.04% and 15.51% inert materials as sand and pebbles.
Main recommendations	it is necessary to include geographical factors including: the problems of urban growth, location of transmission sites of waste and the quality of facilities in any program of collection and disposal of waste
Researchers	Youssouph Sane (ysane1561@rogers.com; bounka@hotmail.com)
Publications	AJEAM / 2002 Ragee; Vol. 4 No. 1, 13-22

4. RESEARCH OUTSIDE THE CONSORTIUM IN NON TARGET REGIONS

4.1.1. Current research in Spain

According to the Spanish National Institute of Statistics (INE in Spanish), more than 49 million euros were spent by innovative companies in 2008 on sanitation, waste management and decontamination. This amount constitutes a 0.4% of the total amount spent in innovation in the private sector.

Activity	Number of Innovative companies in Spain	% of the total companies	Total costs in innovation (thousands of €)	% of total costs
Sanitation, waste management and decontamination	188	0.4	49.074	0.2

Source: Encuesta sobre Innovación en las Empresas. 2008 (INE)

This indicators show that waste management is not yet a priority neither for the private nor for the public sector. Most of the research and innovation in Spain are developed by universities and research centres through public funds from the Spanish government, decentralized autonomous governments and the European Union. Madrid and the northern region is more developed with regards to solid waste management research in Spain, mainly devoted to the exploitation of valuable resources which are usually discharged as residues such as biomass from urban solid waste (research on compost production and biogas production), plastics or glass. Publications of articles regarding solid waste are mainly carried out by departments of chemical engineering, ecology, environment, etc. Nevertheless, there are numerous publications from social science departments (e.g. political economy, ecological economy, etc.) regarding management and economical aspects of solid waste. Many articles are related to the capabilities of regional and local institutions to manage solid waste and their coordination with the national government to achieve a sustainable and efficient management. Lessons of good practices and mistakes of the decentralization process in Spain and the development of their role in the solid waste management of different institutions can be a useful material for Western African authorities dealing with a decentralization process.

Main research centres and institutions are shown below:

Name of research centre	Centro de Recursos per la Protecció de la Salud i el Medi – CRM
Country	Spain
Department	Environment
Contact person	Mrs. Monserrat Gelonch
Email	mgelonch@reus.cat
Title of project	Promotion of a sustainable and integrated urban solid waste management system in the Maghreb countries
Objectives	- Promote sustainable exchanges between stakeholders working in solid waste management north and south of the Mediterranean - Promote the establishment of efficient systems of Solid Waste Management using a community participative

	approach
Short description	This project aims to improve the management of solid waste in several South Mediterranean municipalities. In this project, three urban centres have been chosen in the South Mediterranean countries and one in the North to share and benefit from lessons learned. The project will exchange know-how and experience, while looking to adapt suitable options for improved waste management.
Key findings	Synergy between those responsible for waste management in all four partner countries An experimental waste sorting system is implemented in the partner municipalities: Beni Mellal (Morocco), Sétif (Algeria), Sfax (Tunisia), and Reus (Spain). Pilot waste recovery projects, built on the experimental sorting system, implemented- Results documented and disseminated
Publications	http://ec.europa.eu/europeaid/where/neighbourhood/regional-cooperation/irc/documents/2._lot_1_enpi_south_-_spain_en.pdf

Name of research centre	Polytechnic School of Engineering (University of Oviedo)
Country	Spain
Department	Dept. of Chemical Engineering and Environmental Technology
Contact person	Jesús Rodríguez Iglesias
Email	jesusr@uniovi.es
Title of project	Life cycle analysis of municipal solid waste management possibilities in Asturias, Spain
Objectives	
Short description	In this study, a life cycle analysis has been carried out of the different possibilities of managing Municipal Solid Waste in Asturias. The “Integrated Waste Management” (IWM-1) model was employed, analysing the different alternatives for collection and treatment of MSW.
Key findings	What emerges from this study is the soundness of management strategies based on biological treatment technologies in comparison with thermal treatments, together with the need to increase the level of collection at source.

Name of research centre	Universidad Autónoma de Madrid
Country	Spain
Department	Department of Geology and Geochemistry
Contact person	Dra. Isabel Herráez
Email	isabel.herraez@uam.es
Title of project	Estudio Preliminar de Revisión de la Gestión de los

	Residuos Urbanos en España
Objectives	Reduce the environmental impact of solid waste in Spain
Short description	Hydrological, geological, and chemical studies of residues impact at certain regions
Key findings	Control and characterization of residues discharge
Publications	"Pasado, presente y futuro de la gestión de los residuos urbanos y sus implicaciones en la contaminación de las aguas subterráneas: el ejemplo del centro de tratamiento de Colmenar Viejo" Available at: http://www.bvsde.paho.org/bvsacd/cd27/pasado-presente.pdf

Name of research centre	Universitat Jaume I
Country	Spain
Department	Department of Mechanical Engineering and Construction. Grupo de INGeniería de RESiduos (INGRES)
Contact person	MARÍA DOLORES BOVEA EDO
Email	bovea@emc.uji.es
Title of project	Desarrollo de una metodolgía para la evaluación de sistemas de gestión de residuos urbanos basada en indicadores ambientales, sociales y económicos.
Objectives	Evaluation of solid waste management systems
Short description	Development of an evaluation methodology based on environmental, social and economical indicators.
Key findings	Development of the methodology which has been applied in different regions in Spain.
Publications	Evaluación Ambiental De Alternativas De gestión de residuos: aplicación a castellón de la plana, españa available at https://uninorte.edu.co/divisiones/Ingenierias/IDS/upload/File/Memorias%20II-SIIR/3k-bovea-Espanya-001.pdf

Name of research centre	Gestió Integral de Residus Orgànics (GIRO)
Country	Spain
Department	
Contact person	Xavier Flotats i Ripoll
Email	giroct@giroct.irta.cat
Title of project	PROBIOGAS SP http://www.probiogas.es/
Objectives	Promote and develop energy production systems based on co-digestion of organic residues
Short description	Research activities aim at determining the most adequate techniques and conditions to improve efficient biogas production

Key findings	Manual of anaerobic co-digestion in Spain
Publications	Characterization, purification and control of Biogas Available at: http://www.probiogas.es/

Name of research centre	Gestió Integral de Residus Orgànics (GIRO)
Country	Spain
Department	-
Contact person	Xavier Flotats i Ripoll
Email	giroct@giroct.irta.cat
Title of project	PROBIOGAS SP http://www.probiogas.es/
Objectives	Promote and develop energy production systems based on co-digestion of organic residues
Short description	Research activities aim at determining the most adequate techniques and conditions to improve efficient biogas production
Key findings	Manual of anaerobic co-digestion in Spain
Publications	Characterization, purification and control of Biogas Available at: http://www.probiogas.es/

Name of research centre	Institute of Technology of Asturias (University of Asturias)
Country	Spain
Department	Dept. of Chemical Engineering and Environmental Technology
Contact person	Elena Marañón
Email	emara@uniovi.es
Title of project	Treatment of farm residues in Asturias (Tratamiento de residuos ganaderos en Asturias)
Objectives	- Composting experiments with the solid fraction of manure. - Proposal of treatment for the surplus manure in Asturias. - Design of pilot modular plants
Short description	Optimization of anaerobic reactor functioning, nitrification/denitrification and final treatment of the efluent.
Key findings	So far, the organic matter has been reduced by 85% through anaerobic reactors of high load. Additionally, ammonium nitrification has been achieved with high yields and the denitrification process is being optimized for nitrogene elimination.
Publications	-

4.1.2. Current research in Ethiopia and Sweden

Name of research centre	Addis Ababa University – Addis Ababa Institute of Technology
Country	Ethiopia
Department	Department of Chemical Engineering
Contact person	Dr. Berhanu Assefa
Email	hmberhanu@yahoo.com
Title of project	IGNIS- Income generation & climate protection by valorising municipal solid wastes in a sustainable way in emerging mega-cities
Objectives	This action-oriented research project aims to making use of the value of waste for sustainable income generation. This will include developing adapted technologies, strengthening social status of waste workers, health and safety aspects, environmentally sound waste treatment and economically workable concepts (e.g. local markets, market studies).
Short description	A data basis will be generated. This includes creating a "base map" to provide a spatial basis and socio-economic and waste related data collection. The data collection will be done according to the guidelines. One central scientific basis for the IGNIS approach is experimental pilot projects, such as small scale composting, biogas production, recycling, etc. The pilot projects are expected to be income generating and will be operated by youth groups, women groups, or interested persons who want to introduce a business. When set into effect these pilot projects will be scientifically analyzed in terms of technique, income generation, greenhouse gases and emissions, occupational safety and health and socio-economic aspects to generate the required data for the simulation stage of the project. The results from data gathering and pilot project analyses will be transformed into models that will be incorporated in a simulation program. The IGNIS approach is to find out what would be the effect on job creation, waste reduction, emissions, greenhouse gases, etc., when - hypothetically - many of the successful pilot projects or pilot plants would be introduced or built. We will simulate the potential effects by the help of a simulation tool. The simulation is scenario based. Scenario details, assumptions and parameters will be defined.
Key findings	
Publications	http://www.ignis.p-42.net
	This is a large research project with 4 German and 4 Ethiopian partners. Coordinated by University of Stuttgart
Name of research centre	The Nordic Africa Institute
Country	Sweden/Nigeria

Department	
Contact person	Onyanta Adama-Ajonye
Email	onyanta.adama@nai.uu.se
Title of project	Beyond Poverty: an insight into the informal solid waste recycling sector in Kaduna, Nigeria
Objectives	This research project examines the structure and functioning of the informal solid waste recycling sector in Kaduna, Nigeria. It investigates the role of place-specific conditions in shaping access and the network of relations and interdependence that emerge within and beyond the city.
Short description	However, this research looks beyond poverty to highlight the complexity, dynamism and place-specific nature of the informal solid waste recycling sector. It analyzes issues related to the types of actors; access to urban space; sets of relations formed across different spatial scales; the nature and extent of organizing and the capacity to exert influence with particular attention to how these relate to existing political, economic and socio-cultural conditions.
Key findings	-
Publications	-

4.1.3. Current research in England

Name of research centre	Cranfield University, Bedfordshire MK43 OAL, UK
Country	England
Department	Department of Applied Energy, School of Mechanical Engineering
Contact person	E. Daskalopoulos, O. Badr & S. D. Probert
Email	
Title of project	Economic and Environmental Evaluations of Waste Treatment and Disposal Technologies for Municipal Solid Waste
Objectives	• To categorize the waste fractions obtained • To recommend ways of disposing wastes • To convert putrescible organic material to a stabilized form and to destroy organisms pathogenic to humans. • To check that the control measures adopted remain effective and to identify any loss in efficiency in the control system. • To reviews the main economic costs and the environmental impacts of the widely-accepted waste treatment and disposal methods.
Short description	The disposal of MSW has been the focus of environmental policy for several industrialised countries since the mid-1970s, when attempts were made to identify and categorise, in a systematic way, the waste fractions involved. This paper reviews the main economic costs and the environmental impacts of the widely-accepted waste treatment

	and disposal methods.
Key findings	• Recycling is an alternative waste-treatment technology with acknowledged environmental benefits. • A change in the waste- management policy, combined with a transformation of the consumption patterns is considered to be vital for the success of recycling initiatives.

4.2. Summary

A catalogue of research on solid waste management by organizations outside the consortium in the target countries has been provided in the tables above. All the four beneficiary countries namely, Ghana, Senegal Ivory Coast and Nigeria were covered. Research activities outlined spans the periods 2005 to 2011. Generally research activities centerd on solid waste characterisation and quantification, resource recovery and recyling, and integrated solid waste management systems. Disposal options leading to the classification of areas as safe sites for siting landfills was also undertaken in one of the countries. In addition other novel researches such as the production of second generation biofuels and biochar from lignocellulose waste components have received attention from researchers. The issue of enriching recycled organic waste with nitrogen was also a subject of research for some organisations. Research into proper magement of abattoir waste is also being pursued.

E-waste quantification, valorisation and resource recovery options forms the subject of study for two separate institutions in Ghana and Senegal. The study was also extended to cover Benin and Mali to give it a truly western African colour.

4.3. Conclusion

A complete catalogue of research within and outside of the consortium in the targeted countries has been developed. All research activities related to solid waste management – municipal waste, solid industrial waste and e-waste carried out in the last five (5) years by consortium members have been documented. The catalogues captures the title of the project, objectives, short discription of the project, key findings and recommendations. It also contains the name and email address of the lead researcher or contact person and if any peer reviewed publications emanated from the research conducted.

In addition to this, a list of all institutions in targeted countries that conduct research related to soild waste – municipal waste, solid industrial waste and e-waste management was also documented. All institutions within the targeted countries but outside of the consortium were captured. A database of all researchers in all the targeted countries have thus been compiled. These researchers can be invited to join the consortium as external partners.