



018530 - SWITCH

Sustainable Water Management in the City of the Future

Integrated Project
Global Change and Ecosystems

Deliverable D8, D12 (5.3.3d)

Development of a Technology Selection Model for Pollution Prevention and Control in the Municipal Water Cycle

PhD Research Alberto Galvis

Due date of deliverable: M63
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Start date of project: 1 February 2006

Duration: 60 months

Universidad del Valle

Revision [draft]

Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)		
Dissemination Level		
PU	Public	
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission	
CO	Confidential, only for members of the consortium (including the Commission Services)	X

SWITCH Deliverable Briefing Note

SWITCH Document

Deliverable D8, D12 (WP5.3.3.d)

Development of a Technology Selection Model for Pollution Prevention and Control in the Municipal Water Cycle

Audience

The document has been prepared for an audience inside of the SWITCH consortium. This report is submitted to PhD supervisors (promoter and co-promoter) and the coordination of WP 5.3.

Purpose

The purpose of the document is to present a progress report of the PhD study activities. This report includes also an updated plan to finalize the PhD, after the conclusion of SWITCH Project.

The objective of the investigation is to develop a technology selection methodology to control wastewater pollution that selects options that achieve the optimal cost - effectiveness ratio, while using a basin approach to select the technologies.

Background

This activity corresponds to WP 5.3 (item 5.5.3.d). This PhD, like all the activities of Univalle (Partner #23), initiated in the 2007 (one year after the formal beginning of SWITCH project) because the first payment only arrived at Univalle at the end of 2006.

The PhD proposal was submitted at the beginning of 2009 and approved in the second part of this same year.

Potential Impact

This research is oriented towards the development of a conceptual model of technology selection. The model to be developed includes minimisation and prevention concept, the reuse and the self-purification capacity of the receiving water body as essential elements in the technology selection process. The study area for the development of this model is the Upper Basin Cauca River in Colombia. This research is going to contribute to optimize the investments in pollution control on the base of the implementation of the strategies promoted in the context of SWITCH project and considering the basin like analysis unit.

Issues

Recommendations



UNESCO-IHE
Institute for Water Education



Development of a Technology Selection Model for Pollution Prevention and Control in the Municipal Water Cycle

PhD Research

Progress Report

By Alberto Galvis



March 31, 2011

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Approval PhD research proposal

Appendix 1

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1 RESEARCH PROPOSAL (AS APPROVED BY AC)

In Appendix 1 the letter of approval PhD proposal is presented. Additionally the approved document is enclosed to the present report.

2 RELEVANT ACTIVITIES IN CONNECTION WITH THE PhD PROJECT 2007-2010 (SEE DETAILS IN APPENDIX 2)

2.1 SEMINARS AND SHORT COURSES

I participated in 5 international short courses and 11 international seminars, most of them in the context of the SWITCH project.

2.2 PUBLICATIONS

2007: 3 Chapters in books (Agua 2005); 3 presentations at conferences

2008: 4 Chapters in books (Agua 2007); one paper in Journal (Not directly related to the topic of my PhD thesis)

2009: 2 posters, 2 presentations at conferences

2010: (in press) 3 Chapters in books (Agua 2009); 2 posters

2011: I submitted paper in International Congress in Sevilla (Spain)

2.3 PARTICIPATION IN PROJECTS

I am the project SWITCH coordinator in Univalle. In addition I was the coordinator of other 4 projects. These projects are in connection of my PhD project.

2.4 LECTURER IN GRADUATE (BACHELOR) AND POSTGRADUATE COURSES IN UNIVALLE, CALI, COLOMBIA.

- Technology selection in water supply and sanitation graduate and postgraduate Programs in Sanitary and Environmental Engineering (2007, 2008, 2009,2010, 2011)
- Modelling in Sanitary and Environmental Engineering, in postgraduate program (2009, 2011)
- Sewerage systems in graduate course (2007, 2009 and 2010)

2.5 UNDERGRADUATE THESIS, MSc THESIS AND INTERNSHIPS (2007- 2011)

- 3 Undergraduate thesis completed (two of them in the context of the SWITCH Project.
- 1 Undergraduate thesis in developing (in the context of the SWITCH Project) SWITCH)
- 3 MSc thesis completed (two of them in connection with my PhD; one of them in the context of the SWITCH project)
- MSc thesis on development (all are in the context of the SWITCH Project; In one of them I was advisor. It was supervised by Dr. Patricia Torres and Dr. Jenny Rodriguez, lectures from Univalle, Eidenar School)
- 3 Internship in the context of the SWITCH Project
- 2 Young Researcher Program from Colciencias (Colombian Government)

3 DEVELOPED ACTIVITIES AND PROGRESS REPORT PER CHAPTER

Chapter 2: Cleaner production and other innovative strategies at the basin context for pollution control from municipal wastewater (Overall aim)

- This chapter will be based on the literature review of the PhD proposal and my own experience on the issue. It will be complemented with literature review in the last year. This

literature review has been mainly done for Chapters 1 (specific objective 1) and Chapter 4 (specific objective 3).

- First draft: August, 2011.
- Ending: September, 2011

Chapter 3: Impact of the minimisation and prevention in the integrated water resource management for the pollution control from municipal wastewater (Specific objective 1)

- The literature review was complemented
- Development study case: expansion zone of the Cali city. It includes comparison of the conventional solution versus the solution considering minimisation and prevention strategies in the water pollution control. This case considers the application of strategies as the use of low consumption devices; use of gray water and water rain in the housing. An MSc thesis was completed.
- A sewage system technology conceptual model was developed for municipalities at the Upper Cauca River Basin. This model considers conventional and non conventional urban sewer systems, including sustainable urban drainage systems SUDS. The model was also applied to a housing development at Cali expansion zone. An undergraduate thesis was completed.
- A Revision of activities correspond with this chapter was done with Dr. Peter van der Steen in October, 2010.
- First draft: April 2011.
- Ending: June 2011

Chapter 4: Technology selection in the water pollution control from municipal wastewater considering reuse options (Specific objective 2)

- The literature review was complemented.
- Now I study the potential of the wastewater reuse at the flat zone of the Upper Cauca River Basin. This zone is well known for its sugar cane crops. Several cases have been considered: WWTP - Cañaveralejo influence area, considering the irrigation of sugar cane crops located across the river. Additionally a mid-size city case (Buga, 100.000 inhabitants) was included. These study cases include feasibility analysis considering local regulation and environmental, financial and socioeconomic aspects.
- An MSc thesis was completed in the context of this chapter.
- Discussion of the results: April, 2011
- First draft: June, 2011.
- Ending: July, 2011

Chapter 5: Self purification capacity of the water bodies and its impact in the water pollution control from municipal wastewater (Specific objective 3)

- Some advances in literature review.
- The study case corresponds to Upper Cauca Basin River, considering the natural self depuration capacity of the main stream and the impact of Salvajina Reservoir on the water quality of the Cauca River.
- A new version of Mike 11 model was obtained. Mike 11 allows modeling quantity and quality components of the water bodies under dynamic conditions.
- Information about the hydraulic, hydrologic and water quality aspects of Cauca River (Salvajina – La Virginia) and tributaries were collected.
- Modeling is defined between “La Balsa” station and “Anacaro” station.
- The schematization of the Cauca River between “La Balsa” and “Anacaro”
- The database for calibration/verification of Mike 11 model was prepared.
- Calibration and verification of the new version of Mike 11 model for the Cauca River (La Balsa – Anacaro) was executed. The hydraulic parameters and the water quality parameters (Temperature, BDO, DO) were calibrated.
- The base scenario was defined for 2009. Definition of this scenario included the preparation of database with the frontier conditions, flow and BOD loads of tributary rivers.

- A projection (2019) of pollution loads at the study zone was carried out. This projection includes not only the pollution loads but also the impact of the control strategies planned by the environmental regional (CVC) and local (DAGMA) authorities.
- Data collection of the Salvajina dam operation was initiated.
- Two MSc thesis will be completed in 2011
 - Improvement of Water Quality Downstream by Optimization of upstream reservoir operation. Case study in the Upper Catchment of Cauca River, Valle del Cauca – Colombia. Student: Juan P. Aguilar. Supervisors: Prof. D. Solomatine; Dr. M. Werner; Dr. Schalk Jan van Andel (UNESCO-IHE) and Alberto Galvis (Univalle – Cinara).
 - Water quality modeling of La Vieja River. Student: Juan C. Pulecio. This thesis is in connection with the specific objectives 3 and 4 of my PhD.
- Discussion of the results: September, 2011
- First draft: October, 2011.
- Ending: December, 2011

Chapter 6: A conceptual model for pollution prevention and control from municipal wastewater in the basin context (Specific objective 4)

- This chapter takes the results of previous chapters to build a conceptual model of technology selection considering the basin as analysis unit.
- Chapter 5 activities corresponding to apply the Mike 11 and QUAL 2K model (calibration, verification, database, projection of pollution loads, etc.) will be very useful in the Chapter 6.
- This chapter considers an analysis about the special distribution of the pollution loads discharged to Cauca River (La Balsa-Anacaro). Main tributaries were identified in regards to the pollution load contribution to simplify the schematization of the system for to apply the water quality model.
- A performance evaluation of the wastewater treatment plants of Valle del Cauca municipalities (high basin of the Cauca River) was carried out through a MSc thesis. It was completed in 2010.
- It is possible to consider including a preliminary study about the non-punctual pollution (diffuse pollution) in urban and rural areas. The idea is to evaluate the impact of some minimizing and prevention strategies associated with the application of SUDS in urban areas and the erosion control and the implementation of good practices in the agricultural activities in rural areas. Around this topic, an undergraduate and a MSc thesis will be developed in 2011.
- A preliminary review of WEAP model was done.
- First Discussion of the results: September, 2011
- Second discussion of the results: January, 2012
- First draft: February, 2012
- Ending: April, 2012

Chapter 1: Introduction;

Chapter 7: Discussion and conclusions

- First draft: May, 2012.
- Ending: July, 2012

4 PROGRESS AND STRATEGY TO FINALIZE THE PhD

4.1 DELAY JUSTIFICATION

Although the SWITCH project began in February, 2006, Univalle's activities could only formally initiate one year later. The university began with the participation of WP 1.1 and WP 5.3 in 2007 (SWITCH project year 2). Afterwards, the city of Cali goes from study case in WP 5.3 and becomes as SWITCH Project Demonstration City in 2008. This way, during 2008 (year

3) begins the participation of Univalle in WP 6.2 and in 2009 (year 4) on the issue of Governance (WP 6.1)

Despite the fact of having initiated its participation in the Project, one year later, and began activities as demonstration city two years later, Univalle has made an important effort to meet with opportunity most of the Project commitments. However, PhD studies will not be ready for the end of SWITCH Project. In my case (A. Galvis) I estimate a delay over than year.

4.2 STRATEGY TO FINALIZE THE PhD

PhD proposal was approved. There is a good progress in activities around of Chapters 2, 3, and 4. Following are the main activities executed and a development plan of pending activities.

For 2011 and 2012, the expenses related with PhD studies will be covered by the Cinara Institute through normal resources and resources from specific projects to be executed in 2011-2012. These projects include:

- a) (2007 – 2011) Developing of an integrated water resource management model that promotes the justness, the reduction of the poverty and the development of Colombia, under the concept of sustainable development. Sponsor: COLCIENCIAS. This project will be finished by June, 2012. This project as study area of the Cauca river high basin is the same basin of my PhD Project.
- b) (2011-2012) “Development of a methodology with economic efficiency criteria and implementation of support tools for decision making on water resource planning in the water basins of Colombia – La Vieja River Pilot Basin Application”, with the participation of Univalle, U. Tecnológica de Pereira and U. del Quindío and three regional environmental authorities (CVC; CARDER; CRQ). This Project will be starting in December, 2010. Note: La Vieja River is a tributary of Cauca River.
- c) Colciencias “Young Researcher’ Program”. By this project, Colombian Government finances the participation of newly graduate professionals in research projects (March 2011-February 2012).

APPENDICES

Appendix 1
Approval PhD research proposal



Office of the Director

From
E.A. de Jong, MA
T +31 15 215 17 17
E e.dejong@unesco-ihe.org

UNESCO-IHE
P.O. Box 3015
2601 DA Delft
The Netherlands

Mr. Alberto Galvis C.

Our reference
OD/EDJ

Date
14 October 2009

Subject
Approval PhD research proposal

Dear Mr Galvis,

Your research proposal, entitled " Development of a Technology Selection Model for Pollution Prevention and Control in the Municipal Water Cycle" has been discussed by the Academic Board of UNESCO-IHE.

It is a pleasure for me to inform you that this research proposal is accepted by the Academic Board. Prof. H. Gijzen indicated to be willing to act as your promotor.

According to the PhD rules of IHE, you are officially registered as a PhD-fellow since the date of your enrolment in the PhD programme. This registration is valid until your promotion. An annual progress report is expected from you to be discussed in the Academic Board. In exceptional cases the registration as PhD-fellow may be withdrawn.

Yours sincerely,
UNESCO-IHE



E.A. de Jong, MA
Academic Registrar /
Senior Policy Advisor Academic Affairs

c.c. Gijze, van der Steen

Postgraduate education,
training and capacity
building in water,

Visiting Address
UNESCO-IHE
Westvest 7
2611 AX Delft

T +31 15 215 17 15
F +31 15 212 29 21
E info@unesco-ihe.org
I www.unesco-ihe.org

Appendix 2

4. PARTICIPATION IN SEMINARS AND SHORT COURSES (2007-2010)
5. PUBLICATIONS (2007-2011)
6. PARTICIPATION IN PROJECTS (2007- 2011)
5. LECTURER IN GRADUATE (BACHELOR) AND POSTGRADUATE COURSE
IN UNIVALLE, CALI, COLOMBIA (2011)
- 5 UNDERGRADUATE THESIS, MSc THESIS AND INTERNSHIPS (2007- 2011)

1 PARTICIPATION IN SEMINARS AND SHORT COURSES (2007-2010)

1.1 2007

Note: b, c and d in the context of the SWITCH Project

- a) Regional Refresher Seminar on Urban Wastewater management in the Coastal Areas, organized by UNESCO – IHE and AGUAS & AGUAS, Punta Arenas, Costa Rica, June 3-9 de 2007. In this short course I offered two presentations: a. Technology Selection to Pollution Control from Domestic Wastewater in Colombian Towns between 500 and 30.000 inhabitants; b. Mathematical Modeling of Water Quality in Cauca River, Colombia.
- b) PhD Seminar, UNESCO – IHE, Delft, The Netherlands, June 11 – 15, 2007. Presentation of PhD pre-proposal, Technology Selection Model for Pollution Prevention and Control from Domestic Waste water in Small and Medium Size Towns.
- c) 2nd SWITCH Project - Scientific Meeting, Tel Aviv, Israel, November 25-29 de 2007. Presentation of paper “Technology Selection to Pollution Control for Wastewater of Buga, Colombia”
- d) the Latin American Conference on Sanitation, Latinosan 2007, organized by World Bank (Water and Sanitation Program); Ministry of Environment, Housing and Territorial Development of Colombia; UNICEF, Cinara Institute of Universidad del Valle, November 19 – 23 de 2007. In this conference, I was coordinator of Seminar on “Water Pollution Prevention and Control”.

1.2 2008

Note: a, b and c in the context of the SWITCH Project

- a) PhD Seminar in UNESCO – IHE, Delft March 17-20, 2008. Presentation of “Technology selection for the Buga case (Cauca Valley, Colombia)”
- b) Learning Alliances Meeting, November 26-29, in Ouro Preto, Brazil. Presentation of the Cali, Colombia, like Demonstration City in the SWITCH Project
- c) SWITCH Project -Third Scientific Meeting, November 30 – December 4, 2008 in Belo Horizonte, Brazil.
- d) Ibero-American seminar about the flood risk in urban areas urban. Cartagena de Indias (Colombia), August 25 -29, 2008. Presentation Hydrodynamic Modelling of the Cali City urban drainage in the influence area of the Cali River.

1.3 2009

Note: a, b, c and d in the context of the SWITCH Project

- a) PhD Seminar in UNESCO – IHE, Delft April 6-9, 2009. Presentation of “Technology selection for the Buga case (Cauca valley, Colombia)”
- b) SWITCH Project - Fourth Scientific Meeting, UNESCO – IHE, Delft October 4-7, 2009.
- c) Learning Alliances Meeting the SWITCH Project, October 7-10, 2009.
- d) International Conference AGUA 2009, Seminar “AGUA 2009. Four (4) presentations in Seminar: A new paradigm in integrated water management in urban areas” and one (1) presentations Seminar: Wetlands as Sustainable Technology for Water Management and Climate Change Mitigation”, November 9-12, 2009, Universidad del Valle/Instituto Cinara. Cali, Colombia, November 9-12, 2009.

1.4 2010

Note: a,b, c and d in the context of the SWITCH Project

- a) SWITCH learning and sharing seminar “Integrated Urban Water Management in cities in Latin America”, 16-18 August 2010, Bogota, Colombia

- b) SWITCH Project - Fifth Scientific Meeting, Lodz, Poland, October 13-16, 2010.
- c) SWITCH Training workshop "Technology selection for sustainable municipal wastewater management" Costa Rica, November 22 to 26 of 2010
- d) Sustainable Water Management in Cities: engaging stakeholders for effective change, 13-17 December, 2010, Zaragoza, Spain

1.5 2011

In this year will participate in two international Congress:

- a) Smallwat 11 3rd International Congress. Wastewater in Small Communities. 25th - 28th April, 2011 Seville (Spain). I am member of Scientific Committee of this Congress
- b) 12th International Conference on Urban Drainage, Porto Alegre, Brazil, September 10-16, 2011.

2 PUBLICATIONS (2007-2011)

2.1 Chapters in books

Note: b and c in the context of the SWITCH Project

a) Chapters (8, 17, 21) in book "Avances en Investigación y Desarrollo en Agua y Saneamiento para el cumplimiento de las metas del milenio", Programa Editorial de la Universidad del Valle, Cali, Colombia. October 2007. ISBN: 958-670-608-7.

- Holguin J., Velez C., Galvis A., Ramirez C., Baena L., Duque A. (2007), Implementacion de un Modelo Dinamico para el Estudio de la Calidad del Agua en el Rio Cauca. Chapter 8, pages. 87-96.
- Galvis A., Cardona D. A., Bernal D. P., (2007), Modelo Conceptal de Seleccion de Tecnologia para el Control de la Contaminacion por Aguas Residuales Domésticas en Localidades Colombianas menores de 30.000 habitantes, SELTAR. Chapter 17, pages: 181-190.
- Delgado A., Pulido S., Galvis A., (2007), Modelación Hidrodinámica del Sistema de Drenaje Urbano de la Ciudad de Cali en el Area de Influencia del Rio Cali. Chapter 21, pages: 218-228.

b) Chapters (16, 24, 30,31) in book "Saneamiento Básico y Ambiental en América Latina". The Latin American Conference on Sanitation, Latinosan 2007. Corporación Andina de Fomento (CAF) Cinara-Universidad del Valle, cali, Colombia, June 2008. ISBN. 978-958-44-3433-3.

- Quintero P., Galvis A., Marmolejo L. F., Collazos H (2008). Modelo conceptual de selección de tecnologías para el manejo integral de residuos sólidos em localidades colombianas de 50000 habitantes. Universidad del Valle. Chapter 16, pages: 190-201).
- Martínez A., Galvis A., Holguín J. (2008), Optimización de la Modelación de la Calidad del Agua del Río Cauca. Tramo: La Balsa - Anacaro. (thesis – Sanitary Engineering Univalle). Chapter 24, pages: 289-300.
- Velez C. A., Lobbrecht A., Price R., Mynett A. M., Popescu I., Galvis A., Restrepo I. (2008), Optimization of Urban Wastewater Systems using Model Based Design and Control. Case Study of Cali - Colombia. Chapter 30, pages: 358-370.
- Zambrano, D., Villarreal, C., Galvis, A., Silva J. P. (2008), Análisis de Ciclo de Vida en Sistemas de Tratamiento de Aguas Residuales (thesis – Sanitary Engineering Univalle). Chapter 31, pages: 371-382.

c) Three Chapters in book "Gestión Integrada del Recurso Hídrico frente al cambio Climático". Programa Editorial de la Universidad del Valle, Cali, Colombia (in press). This book will be published in 2011

- Holguin, J., Goethals, P., Galvis, A. (2010). Modelling the Ecological Impact if Wastewaters on the Cauca River (Colombia).

- Smits, S., Galvis, A., Bernal, D., Visscher, J., Santandreu, A., Oliveira de Nascimento, N., Sánchez, E., Butterworth, J. (2010). Mapping governance of urban environmental sanitation in Latin America; case studies from Belo Horizonte, Cali, Lima and Tegucigalpa. En AGUA 2009. Seminar. A new paradigm in integrated water management in urban areas. Universidad del Valle/Instituto Cinara. Cali, Colombia
- Gaviano, A., Zambrano, D., Galvis, A., Rousseau, D. (2010). Application of natural treatment systems for wastewater pollution control in the expansion area of Cali.

2.2 Posters

Note: a and b in the context of the SWITCH Project

- a) Posters in the 4th SWITCH Project Scientific Meeting, October 7-10, 2009
 - Gaviano, A., Zambrano, D., Galvis, A., Rousseau, D. (2009). Application of natural treatment systems for wastewater pollution control in the expansion area of Cali.
 - Galvis, A., Bernal, D., Almario, G., Visscher, J. (2009). Learning Alliances contributing to sustainable water management in Cali, Colombia
- b) Posters in the 5th SWITCH Project Scientific Meeting, October 13-16, 2010
 - Galvis A., Martínez A., Vélez C., Corzo G., Segura L., Sepulveda G. (2010) Developing an early warning prototype to mitigate the pollution effects of the Cauca river in the operation of the water system treatment in Cali, Colombia
 - Zambrano, D., Galvis, (2010). Minimization and pollution prevention as a control strategy of contamination due to domestic wastewater in the expansion area of Cali, Colombia

2.3 Papers in international seminars and conferences

Note: a, b, c and d in the context of the SWITCH Project

- a) Galvis, A., Cardona D. A., Aponte, A. (2007). Technology Selection to Pollution Control for Wastewater of Buga, Colombia. 2nd SWITCH Project - Scientific Meeting, Tel Aviv, Israel, November 25-29, 2007
- b) Galvis, A., Bernal, D., Almario, G., Visscher, J. (2009). Learning Alliances contributing to sustainable water management in Cali, Colombia. AGUA 2009. Seminar: A new paradigm in integrated water management in urban areas. Universidad del Valle/Instituto Cinara. Cali, Colombia.
- c) Montaña, F., Galvis, A., Villaquirán, L. (2009). Selección de Tecnología para la Recolección y Transporte de Aguas Lluvias y Aguas Residuales en Ambientes Urbanos. AGUA 2009. Seminar A new paradigm in integrated water management in urban areas. Universidad del Valle/Instituto Cinara. Cali, Colombia.
- D) Galvis, A.; Bernal, D. P.; Visscher, J. T. (2011) Learning Alliances that contribute to sustainable water management in Cali, Colombia. Smallwat 11 3rd International Congress. Wastewater in Small Communities. 25th - 28th April, 2011 Seville (Spain).

2.4. Papers in journals

Note: These papers are not in the SWITCH Project context and they have not a direct relation with my PhD project

- a) Echeverry D., Cadavid H., Marcos J., Aponte G., Galvis A. 2008. Experimental Results of a Cot-Effective Ozone Generator for Water Treatment in Colombia, Ozone: Science and Engineering.
- b) Galvis A., Quintero Paula A., Saldarriaga G., Buitrago C. A., Burbano F.A. 2007. Proyecto Selección de Tecnología para la Recolección, Transporte, Recuperación, Tratamiento y Disposición Final de Residuos Sólidos en localidades colombianas menores de 50.000 habitantes. Revista ACODAL Año 50 Revista 217 ISSN-0120-0798, Bogota, Colombia

7. PARTICIPATION IN PROJECTS (2007- 2011)

- a) (2010-2013) UNESCO-IHE Partnership Research Fund (UPaRF). FORESEE, Operational Flood Forecasting, Warning and Response for Multi-Scale Flood Risks in Developing Cities UNESCO-IHE Institute for Water Education, The Netherlands, Cinara Insitute Universidad del Valle, Cali, Colombia; Dirección de Prevención y Atención de Emergencias, Bogotá, Colombia; Pontificia Universidad Javeriana, Bogotá, Colombia, National Weather Service – NOAA, USA, Deltares, Delft, The Netherlands.
- b) (2010-2012) “Development of a methodology with economic efficiency criteria and implementation of support tools for decision making on water resource planning in the water basins of Colombia – La Vieja River Pilot Basin Application”, with the participation of Univalle, U. Tecnológica de Pereira and U. del Quindío and three regional environmental authorities (CVC; CARDER; CRQ).
- c) (2007 – 2011) Developing of an integrated water resource management model that promotes the justness, the reduction of the poverty and the development of the Colombia, under the concept of sustainable development. (2006 – 2011). Sponsor: COLCIENCIAS. Agreement UNIVALLE-CIAT-UTP. Main Researcher.
- d) (2006 - 2011) Sustainable Water Management Improves Tomorrow’s Cities’ Health – SWITCH Project (2006 – 2011). Activities 1.1, 5.3; 6.1, 6.2. Sponsor: Sixt Framework Programme, European Union. Project Manager from UNIVALLE, Partner # 23.
- e) (2009-2010) Sentinel of the Quality of the Cauca River Water for the City of Cali. This Project is co-financed by EMCALI and Universidad del Valle, with the participation of other institutions, such as DAGMA and, CVC. Project Manager.
- f) (2007 - 2008) Integrated Urban Wastewater System Data Network (wws.data.net), executed together among UNESCO – IHE and Universidad del Valle. (2007 – 2008). Sponsor: Partnership for Water Education and Research – PoWER. Project Manager from Univalle.
- g) (2007) Technology selection for pollution control and wastewater impact reduction in Buga, Colombia. Sponsor: Corporacion Autonoma Regional del Valle del Cauca CVC (environmental Authority in the Cauca Valley River). Project Manager.

8. LECTURER IN GRADUATE (BACHELOR) AND POSTGRADUATE COURSE IN UNIVALLE, CALI, COLOMBIA

- a) Technology selection in water supply and sanitation
 - In the Postgraduate Program in Sanitary and Environmental Engineering in Universidad del Valle, Cali, Colombia (2007, 2008, 2009, 2010, 2011)
 - In the Program in Sanitary and Environmental Engineering in Universidad del Valle, Cali, Colombia (2007, 2009, 2010,2011)
- b) Modelling in Postgraduate Program sanitary and environmental engineering in Universidad del Valle, Cali, Colombia (2009, 2011)
- c) Sewerage systems In the Program in Sanitary and Environmental Engineering in Universidad del Valle, Cali, Colombia (2007, 2009, 2010)

9. UNDERGRADUATE THESIS, MSc THESIS AND INTERNSHIPS (2007- 2011)

5.1 Undergraduate thesis

Note: b, c and d in the context of the SWITCH Project

- a) Experimental estimation of the kinetic constants of degradation of carbonaceous BOD and nitrogenous BOD in the Cauca River. Sanitary Engineering Program, Universidad del Valle (Student: Cesar A. Garcia) Status: Completed in 2007.

- b) Technology selection for collection and transport of stormwater and wastewater in Urban Areas. Sanitary Engineering Program, Universidad del Valle (Student: Faber Montaña) Status: Completed in 2010
- c) Technical Manual of Sentinel of the Cauca River water quality. Electronics Engineering Program, Universidad Autonoma de Occidente (Student: José Garcia). Status: Completed in 2010
- d) A proposal for sustainable drainage system for low basin Cañaveralejo River Sanitary Engineering Program, Universidad del Valle (Student: Efraín Jimenez) Status: Will be completed in 2011.

9.2. MSc Thesis

Note: c, d, e, f, g and h in the context of the SWITCH Project

- a) A Conceptual Model for the Selection of Wastewater Treatment Technologies - focused on Effluent Reuse at village scale in the Rio Cauca Basin, Colombia. Faculteit der Aard- en Levenswetenschappen Vrije Universiteit. Master of Science Program in Environment and Resource Management 2006 – 2007. (Student: Viviana Gutierrez). Status: Completed in 2007
- b) Modelo conceptual de selección de tecnologías para el manejo integral de residuos sólidos en pequeños municipios colombianos, con énfasis en aspectos tecnológicos MSc in Sanitary and Environmental Engineering in Universidad del Valle (Student: Paula A. Quintero). Status: Completed in 2009.
- c) “Modelling of the Ecological Impact of waste water in the Cauca River”. Academic program of Environmental Sciences at the University of Gent, Belgium (Student: Javier Holguín, member of the Cinara Institute - Universidad del Valle staff) A. Galvis was co-promoter this research together with Professor Dr. Peter Goethals. Status: Completed in 2009.
- d) Analysis of the performance of municipality wastewater treatment plants municipal in Cauca Valley (High basin of the Cauca River). MSc in Sanitary and Environmental Engineering in Universidad del Valle (Student: Claudia L. Suarez). Status: completed in 2010. Note: I was advisor of this thesis. This MSc thesis was supervised by Dr. Patricia Torres and Dr. Jenny Rodriguez, lectures from Univalle, Eidenar School)
- e) Pollution control for waste water in new areas of Cali city considering minimization and prevention strategies. MSc in Sanitary and Environmental Engineering in Universidad del Valle (Student: Diana A. Zambrano). Status: completed in 2011.
- f) Evaluation of the potential of re-use of domestic waste water like strategy for the pollution control in the high basin of the Cauca River (flat zone). MSc in Sanitary and Environmental Engineering in Universidad del Valle (Student: María F. Jaramillo). Status: completed in 2011.
- g) Application of the mathematical modelling to study the hydraulic behaviour and of quality of the water in the river basin of the Palo River, in the high basin of the Cauca River in the Cauca Department (Student: Edda Cifuentes). MSc in Sanitary and Environmental Engineering in Universidad del Valle. Status: will be completed in 2011.
- h) Cali water governance. Study case: Southern drainage system the Cali city. MSc in Political Science (Student: Lyda T. Cordoba). Status: will be completed in 2011

9.3. Internships and younger researcher program

Note: a,b and c in the context of the SWITCH Project

- a) Angela Pinzón, MSc UNESCO-IHE (September – October, 2007). Theme: She participated in the “Urban water management for the Cali City. Diagnosis Report”. This internship was coordinated together with Dr. Damir Brdjanovic (UNESCO – IHE)
- b) MSc Andrea Gaviano from Italy (via UNESCO – IHE) May – September, 2009. Theme: Application of natural treatment systems for wastewater pollution control in the expansion area of Cali. This internship was coordinated together with Dr. Diederik Rousseau (UNESCO – IHE)

- c) Eng. Luisa Calderón, in the context of “Young Researcher Program” from Colciencias. Theme: minimization and prevention as a strategy for water pollution control in the context of integrated water resource management. Status: will be completed in March 2011.
- d) Econ. Pascal Garde, from University of Queensland, Australia. “Critical analysis of the water pollution control framework of the Upper Cauca River Basin, Colombia” , The project will be supervised jointly with Mr. Peter Wegener, Educational Design Specialist at the International Water Centre (IWC) in Brisbane, Australia.
Period: February – July, 2011
- e) Eng. Yelitza Zorrilla “Modeling for to optimize of waste water pollution control investment in the context basin”.
Period: March 2011- February 2012.

Appendix 3

Publications

**Chapters in books, Posters and papers in international seminars and conferences
(Abstracts)**

A CONCEPTUAL MODEL FOR SELECTING TECHNOLOGY TO CONTROL POLLUTION FROM DOMESTIC WASTEWATER IN COLOMBIAN SITES, SELTAR

Galvis, A. *, Cardona, D. A. ** & Bernal, D. P. ***

**Instituto Cinara, Faculty of Engineering, Universidad del Valle. Cali, Colombia. Email: algalvis@univalle.edu.co*

***Instituto Cinara, Universidad del Valle. Cali, Colombia. Email: diamcaze@hotmail.com*

****Instituto Cinara, Universidad del Valle. Cali, Colombia. Email: dipabesu@univalle.edu.co*

ABSTRACT

The water and sanitation sector is beginning to recognise the importance of making suitable technology selections. This recognition is related to the limited impact of much of the investment made in controlling pollution from wastewater, especially in small and medium-sized communities in Colombia and in other Latin American countries.

As part of its work aimed at resolving this situation, in 1999, the Institute Cinara began to develop a technology selection strategy for controlling pollution from domestic wastewater. In 2004, taking these developments as a reference point, an agreement was formalised between IDEAM, the Colombian Institute of Hydrology, Meteorology and Environmental Studies and UTP, the Technological University of Pereira, with the Instituto Cinara as coordinator. This agreement continued the process begun by Cinara of formulating SELTAR, a conceptual model for selecting technology to control pollution from domestic wastewater. The model's chief aims are to prioritise investment and environmental objectives, but it also considers technical, sociocultural, institutional, economic and financial issues. Although the model has been developed for Colombia, most of its criteria and methodologies could be applied to other countries in the region.

The model considers wastewater treatment (104 treatment schemes), as well as sludge management and disposal (9 technological alternatives). SELTAR has already undergone a preliminary process of validation through its application to several Colombian sites, and a national seminar attended by representatives from the environmental authorities of different regions of Colombia.

KEY WORDS

Wastewater, decision model, technology selection, treatment, small and medium communities, pollution control, technology schemes.

OPTIMIZACIÓN DE LA MODELACIÓN DE LA CALIDAD DEL AGUA DEL RÍO CAUCA. TRAMO: LA Balsa – ANACARO

Martínez Anny¹, Galvis Alberto² y Holguín Javier³

¹ Ingeniera Sanitaria, Instituto Cinara - Universidad del Valle.

anyumare@yahoo.com

² Ingeniero Sanitario MSc, Instituto Cinara, Facultad de Ingeniería de la Universidad del Valle.

algalvis@univalle.edu.co

³ Ingeniero Sanitario MSc, Ingeniero del Instituto CINARA - Universidad del Valle. jaholgui@univalle.edu.co

RESUMEN

La aplicación confiable de la modelación matemática como herramienta de planeación requiere de un adecuado proceso de calibración – verificación. Este estudio tuvo por objeto optimizar la modelación de la calidad del agua del río Cauca, el segundo en importancia en Colombia, en el tramo La Balsa - Anacaro. Esta optimización se realizó durante los años 2006 y 2007 utilizando el modelo MIKE11. Incluyó la calibración y verificación del modelo con base en los resultados de dos campañas de monitoreo ejecutadas en el río Cauca en los años 2003 y 2005 y los estudios experimentales relacionados con el balance de oxígeno realizados entre los años 2005 y 2007. Estos estudios incluyeron la estimación experimental de las constantes cinéticas de degradación de la materia orgánica carbonácea y nitrogenada, el estudio de los fenómenos de fotosíntesis y respiración, la estimación de la demanda béntica y el estudio del proceso de reaireación. El trabajo se desarrolló en el marco del Proyecto de Modelación del Río Cauca PMC, ejecutado en convenio entre la Universidad del Valle y la autoridad ambiental de la región (Corporación Autónoma Regional del Valle - CVC). El modelo de simulación de la calidad del agua del río Cauca optimizado se constituye en una herramienta para la planificación integral del recurso hídrico en la zona de estudio.

PALABRAS CLAVES:

Calibración, calidad del agua, modelación, optimización, río Cauca.

**OPTIMIZATION OF URBAN WASTEWATER SYSTEMS USING MODEL BASED DESIGN
AND CONTROL.
CASE STUDY OF CALI - COLOMBIA.**

Carlos A Vélez¹, Arnold Lobbrecht², Roland Price³, Arthur E. Mynett⁴,
Ioana Popescu⁵, Alberto Galvis⁶, Inés Restrepo⁷

¹ Institute for Water Education UNESCO – IHE c.velezquintero@unesco-ihe.org

² Institute for Water Education UNESCO – IHE, HydroLogica. lobbrecht@unesco-ihe.org

³ Institute for Water Education UNESCO – IHE, TU Delft University. price@unesco-ihe.org

⁴ Institute for Water Education UNESCO – IHE, TU Delft University, WL - Delft Hydraulics, a.mynett@unesco-ihe.org

⁵ Institute for Water Education UNESCO – IHE, i.popescu@unesco-ihe.org

⁶ Universidad del Valle, Instituto Cinara, agalvis@univalle.edu.co

⁷ Universidad del Valle, Instituto Cinara, inrestre@univalle.edu.co

ABSTRACT

The pressure on the Urban Wastewater Systems (UWwS) increases as urbanisation continues relentlessly and climate change appears to lead to more extreme rainfall events. These pressures have a negative effect on the efficiency of UWwS to control the urban pollution reaching water-receiving systems. Thus, the urban pollution managers are being forced to optimize the design and operation of UWwS in order to deal with more pressure and new requirements for performance. Traditionally the UWwSs have been designed for steady loading, but are operating under dynamic loading. Thus, only in the rare case when design loading occurs, the system operates optimally. In all other conditions, the build-in capacity is not used or the system cannot satisfy the required performance. Other traditional approach is to design the components of the system separately (sewer network or treatment works), not taking into account the synergies between components and the final goal: limit the pollution reaching the water receiving system. In order to tackle these limitations this paper present an approach named dynamic Model Based Design and Control (MoDeCo). The approach include design of control strategies in the process of the system design, using optimisations routines based in the impact in the water quality in the receiving system and the investments cost. An analysis of the possibility to apply the approach to a case study in Cali - Colombia is presented.

KEY WORDS:

Integrated Urban Wastewater Systems, Wastewater Drainage, Wastewater Treatment, Model Based Design, Real Time Control.

ANÁLISIS DE CICLO DE VIDA EN SISTEMAS DE TRATAMIENTO DE AGUAS RESIDUALES

Zambrano, D.¹, Villarreal, C.²; Galvis, A.³, Silva J. P.⁴

¹Ingeniera Sanitaria, dialeza@yahoo.es, ²Ingeniera Sanitaria, caroreal_1@hotmail.com

³Ingeniero Sanitario MSc, Instituto Cinara, Facultad de Ingeniería de la Universidad del Valle.

algalvis@univalle.edu.co, ⁴Ingeniero Qímico MSc, Escuela Eidenar, Facultad de Ingeniería - Universidad del Valle. pablosil@univalle.edu.co

RESUMEN

Asociado al deterioro de los recursos ambientales, se ha generado la necesidad de identificar mecanismos que permitan la continuidad de las actividades antropogénicas bajo los principios de sostenibilidad. En el control de la contaminación por aguas residuales los procesos de selección de tecnología se han centrado en aspectos técnicos y sociales abordando solo de manera cualitativa la componente ambiental. En este contexto el presente trabajo busca contribuir a la aplicabilidad del concepto de Análisis de Ciclo de Vida ACV en el estudio de impactos ambientales en sistemas de tratamiento de agua residual STAR. Se revisó el estado del arte y se estudiaron varios casos a nivel nacional e internacional. Se analizó su aplicación a STAR y se elaboró una guía donde se relacionaron los aspectos más relevantes para la identificación y cuantificación de impactos ambientales, con el fin de establecer criterios para la identificación del sistema con el menor impacto posible. Para ilustrar el uso de la guía se realizó la comparación de los impactos ambientales de dos sistemas de tratamiento ubicados en el valle geográfico del río Cauca, en Colombia, mediante el ACV. La posibilidad de cuantificar y por tanto, comparar cuantitativamente los impactos ambientales en STAR en una región colombiana, constituye la principal novedad de esta investigación.

PALABRAS CLAVES:

Análisis de Ciclo de Vida, impacto ambiental, tratamiento de aguas residuales, selección de tecnología.

MODELLING THE ECOLOGICAL IMPACT OF WASTEWATERS ON THE CAUCA RIVER (COLOMBIA)

J. Holguin^a, P.L.M. Goethals^b, A. Galvis^c.

^a Center for Environmental Sanitation, Ghent University. Jozef Plateaustraat 22, B-9000. Ghent, Belgium.
jaholgu@hotmail.com

^b Laboratory of Environmental Toxicology and Aquatic Ecology, Ghent University, Jozef Plateaustraat 22, B-9000 Ghent, Belgium

^c Instituto Cinara. Universidad del Valle. Calle 13 # 100-00 Ed. 341. Cali, Colombia.

SUMMARY

The Cauca river is one of most severe cases of contamination for domestic and industrial wastewater discharges in Colombia. One of the most sensitive problems in the Cauca river is the decrease of dissolved oxygen (DO) with concentrations near to zero (0) mg/l in some monitoring stations especially during dry season (low flows conditions). Low DO levels affect the ecosystem equilibrium and the functioning and survival of biological communities. For this reason, the main objective of this research was to contribute to the integrated water quality management of the Cauca river, developing a mathematical model to investigate the ecological quality of this river under actual conditions as well as after different restoration actions. Habitat suitability models (statistical models) that allow predicting the occurrence and the abundance of macroinvertebrates (Ephemeroptera, Trichoptera and Haplotaaxida) in this river under different conditions were built. An integration of these ecological models with the hydrodynamic and physical-chemical water quality model MIKE11 was performed. The integrated ecological model allows to model and to assess the ecological impact of wastewater discharges into the Cauca river and can help to calculate the needed reductions in discharges of organic matter to meet biological quality criteria in this river.

KEYWORDS:

Ecological modelling, habitat suitability models, integrated river basin management, macroinvertebrates, MIKE11

MAPPING GOVERNANCE OF URBAN ENVIRONMENTAL SANITATION IN LATIN AMERICA; CASE STUDIES FROM BELO HORIZONTE, CALI, LIMA AND TEGUCIGALPA

By: Stef Smits, Alberto Galvis, Diana Paola Bernal, Jan Teun Visscher, Alain Santandreu, Nilo Oliveira de Nascimento, Eduardo Sánchez and John Butterworth

ABSTRACT

Cities in Latin America face a double challenge in environmental sanitation, of both providing access to basic water supply and sanitation for those currently lacking that, and improving the collection and treatment of wastewater and solid waste. Understanding and strengthening governance is a crucial factor affecting the way in which these challenges can be met. This report presents a proposed approach for mapping actual governance arrangements, and the underlying framework. It also presents an experience of applying the framework in 4 cities in the region. Lessons from the cities show that standard elements of sector reforms, such as decentralisation, the establishment of regulating entities and setting-up water resources authorities are important components in the strengthening of governance over sanitation. However, strengthening capacity at different levels and developing mechanisms for inclusive and integrated planning, with its accountability mechanisms, are equally important measures. It is therefore recommended that the initiatives towards more integrated urban environmental sanitation, focus on pragmatically working with city stakeholders in activities such as joint planning and facilitating access to and use of information. The approach that has been developed and applied can be considered useful as a method for identifying specific areas where governance needs to be strengthened, and it is recommended that such mapping is applied in longer process of strengthening governance of urban environmental sanitation.

KEY WORDS:

Governance, urban, environmental sanitation, Latin America

APPLICATION OF NATURAL TREATMENT SYSTEMS FOR WASTEWATER POLLUTION CONTROL IN THE EXPANSION AREA OF CALI, COLOMBIA

Andrea Gaviano^{a,b}, Diana A. Zambrano^b, Alberto Galvis^b and Diederik P.L. Rousseau^a

^a *Department of Environmental Resources, UNESCO-IHE Institute for Water Education, PO Box 3015, 2601DA Delft, The Netherlands (andgaviano@gmail.com; d.rousseau@unesco-ihe.org)*

^b *Cinara Institute - Faculty of Engineering of Universidad del Valle, Building 341 - University Campus of Melendez Street 13 No 100-00, Cali, Colombia (dialeza2@yahoo.es; algalvis@univalle.edu.co)*

ABSTRACT

The aim of the present work is to investigate the possibility to apply natural treatment systems in the future expansion area of Cali, Colombia. This area is planned to be a residential zone; extrapolation of current data predicts a future population of 238,916 inhabitants with an average water demand of 142.8 l/s. Several (conventional) alternatives are already designed for the water management of the area. In this work, alternatives concerning anaerobic facultative and maturation ponds, sub-surface flow constructed wetlands, rock filters and fishponds are considered. The comparison in terms of costs with conventional technologies is performed. Results of the design methodology and cost evaluation confirm the applicability and viability of natural treatment systems in the expansion area of Cali. In particular the alternative that has the best results in terms of area requirements and costs is the one that considers the combination of anaerobic and secondary facultative ponds in series.

KEYWORDS

Constructed wetlands, ecotechnologies, waste stabilisation ponds, wastewater treatment

TECHNOLOGY SELECTION FOR POLLUTION CONTROL AND WASTEWATER IMPACT REDUCTION IN BUGA, COLOMBIA

Alberto Galvis*, Diana Cardona and Alexander Aponte

*Cinara Institute, Faculty of Engineering,
Universidad del Valle,
Cali, Colombia*

ABSTRACT

The water and sanitation sector is beginning to recognise the importance of selecting sustainable wastewater management practices and technologies. This recognition is related to the limited impact of much of the investment made in pollution control from wastewater in Colombia, and in other Latin American countries. Important problems to achieve sustainable solutions include: lack of holistic vision; insufficiently working with a water basin perspective; inadequate norms and regulations; focus on “end of the pipe” solutions aimed at the construction of wastewater treatments plants, poor community involvement and institutions working in isolation.

As part of its work to contribute to resolving this situation, Cinara Institute of the Universidad del Valle, of Cali, Colombia, is developing a conceptual model for technology selection for pollution control from municipal wastewater. Initially the study has considered communities with less than 30.000 inhabitants. Now the possibility of involving cities of larger size has been stimulated with the participation of the Cinara Institute in the “Sustainable Water Management Improves Tomorrow's Cities Health” SWITCH Project. In this context and with the support of the environmental authority of the region (CVC) and local institutions, a project was carried out to choose the best technology for Buga, a town of approximately 100,000 inhabitants located in the geographical valley of the Cauca river, the second most important river in Colombia.

This case illustrates the complexity to achieve adequate institutional collaboration and community involvement in technology selection. The case shows several possibilities to find the best technology considering different scenarios, including different environmental objectives, reuse possibilities in agriculture of wastewater treated effluent and the protection of a natural wetland. This case will contribute to adapting the current conceptual model to larger cities.

KEYWORDS:

Pollution control, technology selection, sustainable solutions, treatment, municipal wastewater

SELECCIÓN DE TECNOLOGÍA PARA LA RECOLECCIÓN Y TRANSPORTE DE AGUAS LLUVIAS Y AGUAS RESIDUALES EN AMBIENTES URBANOS

Montaña, F.*, Galvis, A.** y Villaquirán, L.***

* *Instituto Cinara, Facultad de Ingeniería. Universidad del Valle. Cali, Colombia.*

E-mail: fabermondu@yahoo.es

** *Instituto Cinara, Facultad de Ingeniería. Universidad del Valle. Cali, Colombia.*

E-mail: algalvis@univalle.edu.co

*** *Empresas Municipales de Cali. Cali, Colombia. E-mail: lvillaquiran@emcali.com.co*

RESUMEN

El desarrollo de áreas urbanas implica la provisión de sistemas de drenaje para la evacuación de aguas de escorrentía y aguas residuales. Aunque los sistemas de alcantarillado combinado y separado han sido las tecnologías utilizadas tradicionalmente para tal fin, existen otras opciones que podrían ser implementadas de acuerdo a las condiciones locales. Las diferentes características de cada contexto, las múltiples opciones tecnológicas para el drenaje urbano y los problemas relacionados con conexiones erradas, descargas de estructuras de separación y descargas del primer lavado al cuerpo receptor, dificultan la selección de tecnologías sostenibles para cada contexto. Con el propósito de ayudar en la toma de esta decisión, se desarrolló un modelo conceptual de selección de tecnología para la recolección y transporte de aguas lluvias y aguas residuales en ambientes urbanos, con énfasis en aspectos tecnológicos. El modelo considera dentro de las alternativas de selección cinco opciones de sistemas urbanos de drenaje sostenible (SUDS), el drenaje superficial, el alcantarillado pluvial, el alcantarillado combinado, el alcantarillado sin arrastre de sólidos, el alcantarillado simplificado y el alcantarillado sanitario convencional. El modelo propuesto fue aplicado a un estudio de caso, donde se encontró que la opción más adecuada es un depósito de detención junto con un alcantarillado combinado.

PALABRAS CLAVES

Drenaje urbano; selección de tecnología; sistemas de alcantarillado; sistemas urbanos de drenaje sostenible (SUDS)

LEARNING ALLIANCES THAT CONTRIBUTE TO SUSTAINABLE WATER MANAGEMENT IN CALI, COLOMBIA

Galvis, A.*; Bernal, D.P.**; Visscher, J.T***

* *Cinara Institute, School of Engineering, Universidad del Valle, Calle 13 #100-00 Building 341,*
alberto.galvis@correounivalle.edu.co

** *Cinara Institute, School of Engineering, Universidad del Valle, Calle 13 #100-00 Building 341*
dipabesu@univalle.edu.co

*** *IRC International Water and Sanitation Centre, POBox 82327, The Hague, Netherlands;*
visscher@irc.nl

ABSTRACT

Cali, Colombia, is one of the demo cities in the Sustainable Water Management Improves Tomorrow's Cities's Health" SWITCH Project (2006-2011) of EU Six Framework Program. This project involves the participation of 33 different institutions from Europe, Africa, Asia, and Latin America. SWITCH seeks a paradigm shift in water management in urban areas and involves addressing issues associated with: urban drainage systems, water supply, multiple uses of water, rational use of water, sanitation, domestic and industrial wastewater management, urban water cycle, planning, governance, and institutional factors. The project includes research, training, communication and demonstration activities. The concept of demo cities is based on the strategy of Learning Alliances LA. This paper shows the experience about the LA in Cali focusing on alternative approaches to wastewater management. This experience entailed conducting a participatory diagnosis and a review of plans, programs, and projects proposed by local and regional institutions as well as building a common vision, devising scenarios, and establishing strategic action lines. SWITCH Cali has contributed to the scientific basis for IUWM in urban areas and the formulation of public policies in the Upper Cauca River Basin.

KEY WORDS:

Learning Alliances, Wastewater, Sustainability, Strategic Planning, Cali city.

Appendix 4

MSc Thesis - Abstracts

MODELLING THE ECOLOGICAL IMPACT OF WASTEWATERS ON THE CAUCA RIVER (COLOMBIA)

Student: Javier Ernesto Holguin, Master of environmental Sanitation
Universiteit Gent, Belgium

Promoters:

Prof. Dr. ir. Peter Goethals
Prof. M.Sc. Alberto Galvis

SUMMARY

The Cauca river is one of most severe cases of contamination for domestic and industrial wastewater discharges in Colombia. The rapid urbanization and major economic development in the Cauca river's geographical valley has led to dramatic degradation of the environment and increased health risks due to inefficient processing of the increased pollutant load effluents and solid wastes. This river during the year 2005 received in average 195 tons of organic matter load per day in terms of BOD₅ in the study zone. The high discharge of organic matter causes a high oxygen demand in the degradation process. Thus, one of the most sensitive problems in the Cauca river is the decrease of dissolved oxygen (DO) with concentrations near to zero (0) mg/L in some monitoring stations especially during dry season (low flows conditions). Low DO levels affect the ecosystem equilibrium and the functioning and survival of biological communities. For this reason, the main objective of this research is to contribute to the integrated water quality management of the Cauca river in Colombia, developing a mathematical model to investigate the ecological quality of this river under actual conditions as well as after different restoration actions.

The approach followed was to build statistical models that allow predicting the occurrence (multiple logistic regression models - MLRMs) and the abundance of macroinvertebrates (quasi-Poisson regression models - QPRMs) in this river under different conditions. Afterwards, an integration of these ecological models with the hydrodynamic and physical-chemical water quality model MIKE11 was performed. Finally, applications of the integrated ecological modelling were made for predicting the ecological impact of the scenarios for pollution control in the Cauca river's basin.

The assessment of the MLRMs reliability showed that the models for Ephemeroptera (AUC=1), Trichoptera (AUC=1), and Haplotaxida (AUC=0.926) correctly discriminates between occupied (presence) and unoccupied (absence) sites in the dataset. Regarding the predictive validation procedure for QPRMs, it was found that in general the models reproduce with good precision the tendencies and the maximum and minimum values of abundance data for each macroinvertebrate (i.e. Ephemeroptera, Trichoptera and Haplotaxida) and the BMWP index, with high R² values ($0.866 < R^2 < 0.998$).

The application of the integrated ecological modelling of the Cauca river showed that the MLRMs and QPRMs predict well the ecological impact of the scenarios for pollution control in the Cauca river's basin. Thus, in the scenario with the highest pollution reduction an improvement of the water quality of the Cauca river is achieved, which is represented with the presence and/or an increase of the number of pollution sensitive benthos (i.e. Ephemeroptera and Trichoptera) and the absence and/or a decrease of the number of pollution tolerant benthos (i.e. Haptaxida). On the other hand, if the worst pollution condition scenario is considered a deterioration of the water quality is obtained, which is represented with the absence and/or a decrease of the number of pollution sensitive benthos and the presence and/or an increase of the number of pollution tolerant benthos.

The integrated ecological model proposed in this research is a powerful operational tool, which allows to model and to assess the ecological impact of wastewater discharges into the Cauca river and can help to calculate the needed reductions in wastewater discharges of organic matter to meet biological quality criteria in this river.

**ANALYSIS OF THE PERFORMANCE OF MUNICIPALITY WASTEWATER TREATMENT
PLANTS MUNICIPAL IN CAUCA VALLEY (UPPER CAUCA RIVER BASIN)**

Student: Claudia Lorena Suarez
MSc Sanitary and Environmental Engineering
Universidad del Valle , Cali, Colombia

Promoters:
Jenny Rodríguez, PhD
Patricia Torres, PhD

Advisor:
Alberto Galvis, MSc

SUMMARY

The main aim of this research was to contribute to the enhancement of the wastewater plant treatment performance from the region of the Valle del Cauca, in the areas of design, construction, operation, maintenance and performance. It was proposed as specific objectives to diagnose the plant wastewater treatment in the municipalities of Valle del Cauca Department, analyzing the information in the environmental agency on performance, identify water treatment plant (WWTP), define the critical factors that affect the operation and performance, and finally, propose strategies for the optimization of the evaluated wastewater treatment plants.

In the identification stage it was found out the dominant technology in the region is the treatment by stabilization ponds, and in second place is the UASB reactor configuration followed by a trickling filter. After the study of each technology it was identified the critical factors related with the design, such as an inadequate selection of the parameters and inappropriate configurations. Also it was found some aspects related with the wrong positioning of some operation units and the use of non-recommended materials in the construction. For the maintenance and operation it was found deficient periods of measurement and control of the process, i.e. long delay time for the measure of the process variables and not enough technical instruction to the operators of the plant.

It was proposed some strategies of optimization of the identified critical points based on the experience in other WWTP, which are under similar conditions with the studied plants, aimed to solve those limitations in a simple and practical way.

Despite the found limitation in the design, construction, maintenance and operation activities of the wastewater treatment plants, the adopted technologies were considered sustainable for the environmental and socio-economic situation of the region of the Valle del Cauca. Moreover, their efficiency is quiet acceptable. It's considered that other technologies for wastewater treatment

different to the stabilization ponds and the configuration of a UASB reactor followed by a trickling filter could not work out better than them. However, it's required to pay more attention in the design and maintenance processes of the wastewater treatment plants to warranty the well performance of the system.

The research was supported by the SWITCH project "Sustainable Water Management Improve Tomorrow's Cities' Health", which focuses on developing effective and sustainable water management in urban areas.

POLLUTION CONTROL FOR WASTE WATER IN NEW AREAS OF CALI CITY CONSIDERING MINIMIZATION AND PREVENTION STRATEGIES

Student: Diana Alexandra Zambrano
MSc Sanitary and Environmental Engineering
Universidad del Valle, Cali, Colombia

Promoter: Alberto Galvis, MSc.

SUMMARY

The pollution generated by the wastewater in urban areas is a growing problem tackled with punctual approach, and of correction through implementation of tools focused in tax payment and/or the use of treatment systems with lacking or inadequate selection process, without consider factors such as the space-temporary distribution of pollution, the objectives of treatment, economical aspects, and socio-cultural, leading to solutions not much effectives. For solve this problematic is promotes the formulation of new strategies addressed to preventive water management and integral, considering the water scarcity, requiring efficient measures for their use in function of the multiples uses. This research is focused in the identification and selection of strategies for urban water management including pollution prevention and minimisation through integration of water supply, sanitation, and stormwater drainage like as a pollution control mechanism with emphasis in technological aspects, considering the uses, water distribution, the environmental characteristics, local conditions, policy, socio-cultural criteria and economical; for selection of a strategy in function of optimise and prioritize the investment in pollution control. The study area to identification and selection of strategies is the south expansion area of Cali city.

As results of this research can be mentioning that for south expansion area is feasible the implementation of low consumption devices and the implementation of other sources coming from greywater reuse and rainwater harvesting. The application of these strategies implies a diminution of impact generates for this area to water resources. The pollution prevention and minimisation strategies in the south expansion area represent economical benefits, since to analyse the cost-benefit relation is found considerable savings in public services payment by users, and decrease in requirement of initial investment of external network of drinking water system, sewer system, pumping systems, and wastewater treatment, making economically feasible the application of this proposal.

This research is developed in framework of SWITCH project, supported by Framework Programme Six (FP6), and technological develop of European Union.

**EVALUATION OF THE POTENTIAL OF RE-USE OF DOMESTIC WASTE WATER LIKE
STRATEGY FOR THE POLLUTION CONTROL IN THE HIGH BASIN OF THE CAUCA
RIVER (FLAT ZONE)**

Student: María Fernanda Jaramillo
MSc Sanitary and Environmental Engineering
Universidad del Valle , Cali, Colombia

Promoter: Alberto Galvis, MSc.

SUMMARY

The potential of agricultural reuse domestic wastewater was characterized by three case studies in the Cauca river valley in the department of Valle del Cauca. The methodology for identifying potential can be divided into three stages that correspond to the documentation of experiences of agricultural reuse in the region, the implementation of socio-economic assessment as a tool to characterize the potential for agricultural reuse under the concept of sustainability and the development a proposal in the context of integrated management of domestic wastewater.

The results show that the implementation of the practice of agricultural reuse is determined by four factors: the financial factor, the technical factor, the environmental factors and cultural factors. These factors evaluated in the three case studies helped identify the potential of integrated agricultural reuse water management of WWTP-C. For the case study of wastewater management in the area of expansion, the conditions of temporary irrigation practice did not benefit positively the implementation of agricultural reuse. In the case of treated waste water management in the municipality of Buga the benefit-cost presents a socio-economic terms indifferent decision to implement reuse.

This research is developed in framework of SWITCH project, supported by Framework Programme Six (FP6), and technological develop of European Union.

TECHNOLOGY SELECTION OF DRAINAGE SYSTEMS FOR EVACUATION OF STORMWATER AND WASTEWATER IN URBAN AREAS

Student: Faber Montaña
Sanitary Engineering, Universidad del Valle, Cali, Colombia

Promoter: MSc Alberto Galvis

SUMMARY

The development of urban areas implies the provision of drainage systems for evacuation of stormwater and wastewater. Although the combined and separated sewer systems, has been the technologies used traditionally, there are other options that could be implemented according to the local conditions. The several characteristics of each context, the many technological options for urban drainage y the issues related with illegal connections, overflow of the combined system, and discharges of the “first flush” to the receiving body, difficult the sustainable technology selection. With the objective of help to the decision making, a conceptual model of technology selection for collection and transport of stormwater and wastewater from urban environment was developed, with a approach in technological aspects. The model considers five options of Sustainable Drainage Systems (SUDS), superficial drainage, stormwater system, of simplified sewer, and of conventional sewer system. The model was applied to case study, where in the option selected was implement two detention deposits with a combined sewer system.

This research was developed within SWITCH Project “Sustainable Water Improves Tomorrow’s Cities’ Health”, which is focused in to effective develop and sustainable of the urban water Management.