

Foreword

I am very pleased to present this year's annual report. It always feels good when one looks back at a year's worth of work and realise how much has been achieved. This is the case for the second year of the Institute. Major efforts were made on three fronts. First was the outreach and exposure of the Institute to a number of University departments, local and foreign organisations and research groups. Second was the hard work at putting together new study programmes in Geographic Information Systems and Sustainable Land and Real Estate Management. The excellent reviews of these programmes go to show that we are on the right track to achieving interdisciplinarity and high quality in our study programmes. Third has been the research front. The small collaboration initiated last year with the Faculty of Engineering has reaped considerable fruits. Not only was the research team accepted to present at the 11th International Conference for GeoComputation in London and to submit their paper for review in Computers, Environment and Urban Systems, a prestigious international journal, but also it has developed into a formal research group extending (until now) the collaboration to the Faculty of ICT and the Faculty of the Built Environment. The TISTA (Transport Information Systems and TelemAtics) Research Group has been set up to foster interdisciplinary research in the area of transport. The hard work by the Entrepreneurship Unit Head and the Director of Corporate Research and Knowledge Transfer has also been successful with the award of ESF funding for the development of entrepreneurship courses to be offered by the Institute next year. It is important to also highlight some of the projects which the Institute has been awarded this year, like the Assessment of key success indicators for the Public Transport Reform in Malta, a project awarded by Transport Malta and the E-skills Demand and Supply Monitor commissioned by INSEAD. The Institute is also active within the University community, providing for the development of an interactive campus map, leading the Green Travel Initiative at the Msida Campus and developing the WebGIS project for the community. These are just the highlights of what has been achieved this year. I invite you to read more and why not, get in touch!

Dr Maria Attard
Director, Institute for Sustainable Development

Introduction

The Institute for Sustainable Development was established in 2009.

During 2010-2011 the Institute embarked on a number of new projects and contract work, published its first research work at an International conference and developed new, interdisciplinary study programmes.

The Board of the Institute met regularly during this year where a number of key decisions were taken with respect to the work of the Institute and the development of new study programmes and projects.

This report outlines the work and achievements of the Institute for Sustainable Development during the period October 2010 and September 2011.

This report outlines the work and achievements of the Institute for Sustainable Development during the period October 2009 and September 2010.

The Board of the Institute

Chairman Prof. Juanito Camilleri

Vice-Chair and Director Dr Maria Attard

Appointed by Senate Prof. Richard Muscat

Appointed by Council Dr John A. Schembri

Appointed by the Faculty of Economics Management and Accountancy Dr Gordon Cordina

Appointed by the Faculty of Engineering Prof. Simon Fabri

Appointed by the Faculty of the Built Environment Prof. Alex Torpiano

Appointed by the Faculty of Science Dr Sandro Lanfranco

Appointed by the Faculty of Information and Communication Technology Dr Ing. Saviour Zammit

Aims of the Institute

- (a) to assist by interdisciplinary research in the realisation of national plans to improve the infrastructure, productivity, entrepreneurship and the quality of life in Malta;
- (b) to provide advice and assistance on issues of sustainable development in Malta;
- (c) to promote the use of, and deploy Geographic Information Systems and other information systems as a tool for decision support and strategic planning;
- (d) to promote and catalyse science and technology commercialisation, the creation of start-ups and new business ventures, and the transfer of innovation and technology to industry;
- (e) to organise undergraduate and postgraduate courses within the scope of the Institute subject to the Statutes and Regulations of the University;
- (f) to network and liaise with similar, university institutions and centres for sustainable development overseas; and
- (g) to disseminate the knowledge acquired by publication, seminars and teaching programmes.

The University of Malta Institute for Sustainable Development

The Administrative Office

During 2010-2011 the Institute was located in Regional Building, Triq l-Imhalled Paolo Debono, outside the University Msida Campus. This temporary office housed the administrative as well as the academic staff, whilst also offering space for interns, students and project work which the Institute maintained and ran throughout the year.

The Institute's Human Resources

Ms Stephanie Stellini, a Graduate Trainee appointed with the Institute in 2009 still manages successfully the administration of the Institute including the financial, HR, contracts, projects and summer school organised by the Institute.

Ms Thérèse Bajada, appointed as Resident Assistant Lecturer in January 2010 has continued successfully her PhD studies at UCL's Civil, Environmental and Geomatic Engineering Department and contributed to the various projects and teaching duties within the Institute.

Dr Ing. Saviour Zammit (Lecturer in the Faculty of Information and Communication Technology) continued to coordinate the Science and Technology Entrepreneurship Unit within the Institute. Recently he was awarded (in collaboration with Dr Anton Bartolo of the Corporate Research and Knowledge Transfer Office of the University), ESF funding to develop programmes in Entrepreneurship.

Prof. Juanito Camilleri, currently the Rector of the University, made a formal request in 2011 to join the academic faculty of the Institute for Sustainable Development. The request was approved by the Staff Affairs Committee and well received at the Institute.

Community Outreach

The Institute Website

The Institute website has continued to act as a medium for communication with the University community and the general public. The Institute's website contains reference to almost all the work that the Institute engaged in since its opening in 2009. Sections in the website include:

- The Homepage which provides an introduction to the Institute, the latest news, and direct links to the study programmes (Courses) offered by the Institute;
- An About page containing the link to the Institute Statute, the composition of the Board, its Director and the 2009-10 Annual Report;
- A Staff page containing the contact details and link to personal pages of the staff compliment of the Institute;
- A News page listing all the news events published by the Institute;
- An Events page providing information on the various events organised by the Institute;
- A Research page where interested researchers wishing to carry out research with or at the Institute can download the Guidelines for the Preparation of Research Proposals;
- A Links page which lists interesting and relevant websites;
- A page dedicated to the European Commissions Joint Research Centre (JRC) initiatives and events;
- A Working Papers page where interested researchers can download the Guidelines for the Preparation

- and Submission of Working Papers to the Institute's Working Paper Series;
- A Media Coverage page which lists the instances where the Institute was reported on the media;
- A UOM Green Travel Plan Initiative page where staff and students at the University can refer to the developments on the University's Green Travel Plan.
- A TISTA page providing information about the Institute's new initiative Transport Information Systems and Telematics (TISTA) Research Group.

Pages from the Homepage link to the study programmes offered by the Institute including the Diploma in GIS, the Diploma in Sustainable Land and Real Estate Management, the Post-graduate Certificate in Geographic Information Systems and Science and the MSc by Research.



www.um.edu.mt/isd

The Institute in the Media

Press Releases

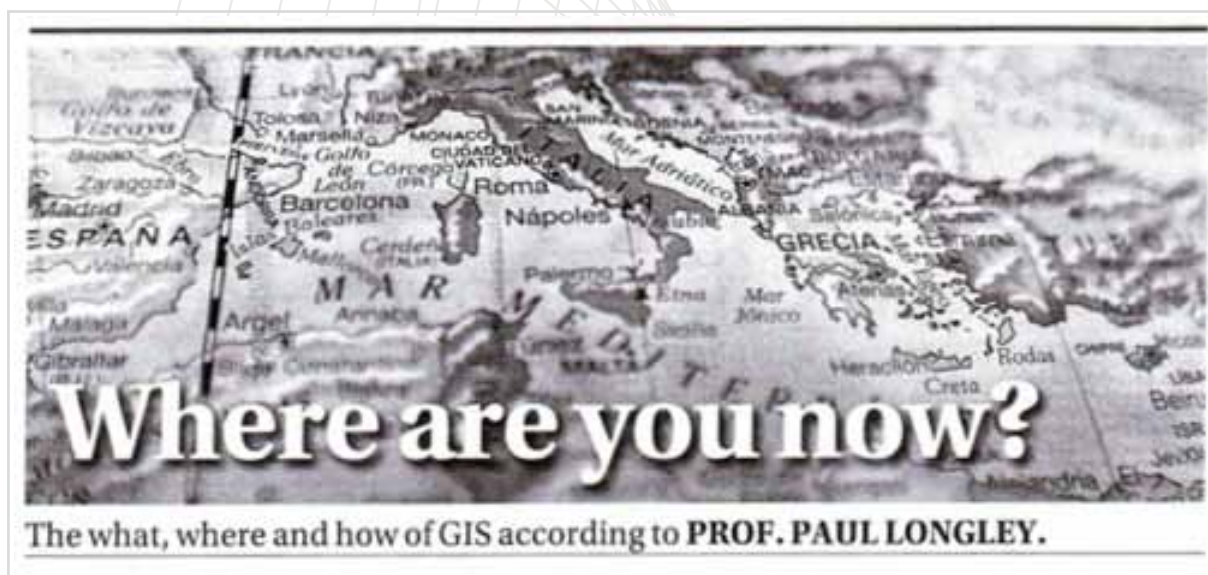
Visiting Professor at the Institute for Sustainable Development



The Institute for Sustainable Development is pleased to host Professor Paul Longley, Professor of Geographic Information Science from University College London (UCL). Prof Longley has published 14 books and more than 125 refereed journal articles in the area of Geographic Information Systems. He has held over 40 research grants and has supervised more than 35 Ph.D. students (most funded by research councils). He is journal editor to a number of prestigious academic journals and has held ten externally-funded visiting appointments and given over 150 conference presentations and external seminars. He teaches Geographic Information Systems and Science and is a co-author of the best-selling book of that name.

During his stay at the Institute, Professor Longley will give lectures about 10 years of Geographic Information Systems, since the publication of the Big Book of GIS which he co-authored with other leading academics in the subject as well as cover an increasingly important aspect of modeling, Fractals. On Thursday 14th April, Prof Longley will be accompanied by local experts, such as Prof. Joseph Brincat from the Faculty of Arts, to discuss the topic of family names in Malta and beyond. Prof Longley has been engaged in the study of the geography of family names and has produced a tool to support such studies. Information about his project is available at www.publicprofiler.org.

Visiting Professor Paul Longley talks to Stanley Borg Technology Sunday Editor

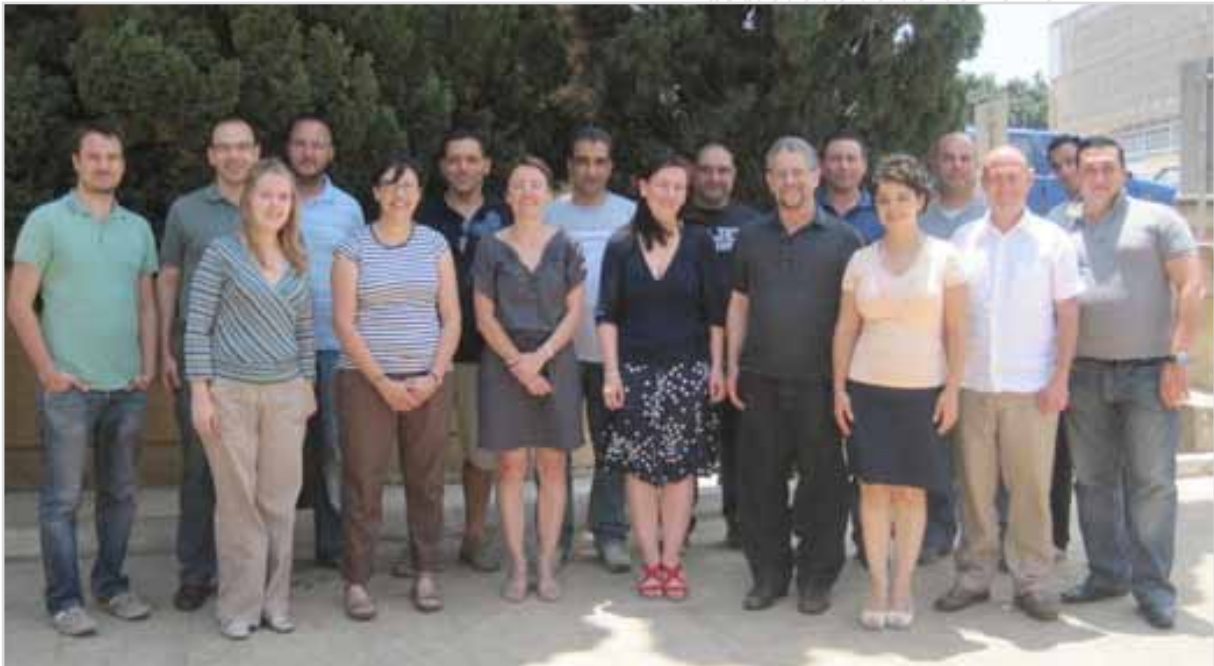


Visiting Professor to the Institute for Sustainable Development, Professor Paul Longley discusses the what, where and how of Geographic Information Systems in an interview with Technology Sunday editor Stanley Borg, 24th April 2011.

The 2011 Summer School in Spatial Data and Geographic Information Systems

The Institute for Sustainable Development, University of Malta in collaboration with the Department of Civil, Environmental and Geomatic Engineering, University College London (UCL) has once again successfully completed a Summer School on Spatial Data and Geographic Information Systems which was held between the 13th and 17th of June 2011 at the University Msida Campus.

The Summer School attracted a group of delegates who were interested in creating and analysing spatial data. The delegates had the opportunity to apply GIS using spatial statistical techniques available in GIS software and investigate aspects of data quality. This year students experienced hands on sessions on the creation of spatial data from digitizing to the use of GPS (Global Positioning Systems). The use of GPS equipment during the summer school allowed for students to appreciate how spatial data is created and how GPS interface with GIS. The method used in the delivery of the summer school was a mix of lectures and hands-on sessions. The delegates included research students, technical staff from utility companies and government agencies as well as foreign students.



The teaching faculty consisted of Dr Maria Attard (UOM), Dr Muki Haklay (UCL), Dr Helena Titheridge (UCL), Dr Claire Ellul (UCL) and Ms Thérèse Bajada (UOM). Dr Kate Jones (Portsmouth) also contributed as visiting lecturer to this year's summer school.

The success of the summer school in this growing area of study is very encouraging and will certainly ensure that the Institute continues to further develop study programmes in this area and continue the collaboration and research with leading institutions abroad.

The Sunday Times 18th July 2011

Bright green ideas

Dr Maria Attard, Director of the Institute for Sustainable Development, is interviewed by Veronica Stivala on how through the use of Geographic Information Systems technology, the future is green.

Interview

MONEY Magazine, the Eco and IT Issue 08, July/August 2011



Interview

Bright green ideas



Predicting parking spaces, on-demand public transport and interactive local maps - thanks to Geographic Information Systems technology, the future is green, Dr Maria Attard tells Veronica Stivala. Photo by Christian Sant Fournier



Wouldn't it be great if you could decide in advance whether to take the bus or your car to a location

is, the integration of telecommunications and informatics. By using the University as a microcosm for Malta, the ICT faculty is studying parking schemes that make car use more efficient. This research could eventually be used to develop applications which can be accessed in almost real time on your phone so you can see the current spaces available. If the system is sophisticated enough, it can even forecast what spaces will be available in the next half an hour or so, Genius.

Needless to say, once the system is created, it can easily be set up for parking lots all over the island and, who knows, the rest of the world.

Launched under two years ago, the Institute for Sustainable Development is brimming not just with ideas but

“One of our objectives is to promote the use and further deployment of Geographic Information Systems and other information systems as a tool for decision support and strategic planning.”

“One of our objectives is to promote the use and further deployment of Geographic Information Systems and other information systems as a tool for decision support and strategic planning,” explains Dr Attard.

It goes without saying that technology is an efficient way of doing things and allows us to look at data in a better way – just think of interactive 3D maps and calculating travel time.

“We want to get our researchers to think how they can use technology to solve their problems,” says Dr Attard.

To encourage this, a research group was set up a couple of months ago to focus research on, for example, networks, information systems and transport.

Green Travel at University

The Institute for Sustainable Development in collaboration with the Director of Estate and Works is spearheading the Green Travel Initiative at the University. At the launch of the Green Travel Initiative, entitled Travelling Smart Dr Maria Attard, Ing. Christopher Spiteri (Director, Estate and Works) and Mr Stefan Balzan (KSU President) told the press and the audience about the objective of the Green Travel Plan and how, through the setting up of a GTP Committee, the University intends to encourage sustainable mobility amongst staff and students.



Times of Malta Online Tuesday 27th September 2011

The Sunday Times, Sunday 26th September 2011

Participation in conferences and events

21-23 October 2010 International Conference on Ecological Landscape Modelling and Management for Mediterranean Islands - Gozo, Malta

Dr Maria Attard delivered a presentation entitled 'Supporting Sustainability through geographic information and public participation – civic science and stakeholder involvement in the Eco Gozo Project' at this conference organised by Anhalt University of Applied Sciences, Germany.

29-30 November 2010 Joint Programming Initiative Urban Europe, Visioning Workshop - Vienna, Austria

Dr Maria Attard participated as the scientific expert representing Malta at the Visioning Workshop organised by the Austrian Institute of Technology (AIT) for the development of the JPI Urban Europe.



2-3 February 2011 Joint Programming Initiative Urban Europe Conference - Amsterdam, Netherlands

Dr Maria Attard attended the conference as scientific expert representing Malta organised by the Free University of Amsterdam to support the development of the Strategic Research Agenda (SRA) for the JPI Urban Europe.

14-19 March 2011 University Open Week - Msida Campus, Malta

During Open Week Dr Maria Attard delivered two talks on the Application of Geographic Information Systems and Sustainable Mobility on the main campus whilst Ms Thérèse Bajada prepared a poster entitled Modelling Sustainability in Transport. The Case of the Public Transport Reform in Malta. A presentation was also made to students and interested parties about potential funding for students. The funding opportunities discussed were the Malta Government Scholarship Scheme, STEPS and the opportunities for short-term visits to JRC Institutions.

30 March 2011 MISTRALS International Workshop - Valletta Campus, Malta

Dr Maria Attard attended the MISTRALS International Workshop. MISTRALS is an international collaboration involving various departments of the University of Malta and CNRS, amongst others.

7-9 April 2011 Qualitative Consumer Research and Insights 2011 (QCRI2011) - Sliema, Malta

This round-table meeting organised by the Merlien Institute brought together top academics, consumer insights executives and market research practitioners to discuss, debate and brainstorm cutting-edge qualitative research techniques while converting results into actionable business propositions. The innovative methods discussed in the conference included the recent online networking models. Ms Thérèse Bajada represented the Institute for Sustainable Development at this meeting. The Merlien Institute is a Singapore based private research institution.

4 May 2011 CNRS (French National Centre for Scientific Research) Meeting - Msida Campus, Malta

The Institute participated in the various initiatives organised by the newly set up CNRS Office. In this first meeting Dr Lalo presented CNRS and requested interested researchers to submit their interests in collaborative research. In response to this, the Institute for Sustainable Development provided a comprehensive list of research interests and publications related to urban transport which it would like to pursue through CNRS and Université Lumière Lyon 2: Laboratoire d'Economie des Transports.

5 May 2011 International Conference on Sustainable Construction, Civil Engineering and the Built Environment - St Julian's, Malta

At this international conference, organised by the European Council of Civil Engineers and the Kamra tal-Periti (Chamber of Architects and Civil Engineers, Malta), two papers were presented from the Institute for Sustainable Development. These were Bajada, T. and Attard, M. Using Geographic Information Systems as a Tool to Improve Road Safety and Attard, M. A preliminary assessment of the Park and Ride Scheme in Floriana, Malta.

10-15 May 2011 International gathering of the Young People and Science in Society Issues (YPSSI) - Athens, Greece

During the week starting the 10th of May, Athens saw the gathering of a group of young people from 16 European countries for discussions on issues related to sustainable development. The event was organized by the Greek NGO "Day After" with the intention of providing an opportunity for the members of the European network YPSSI to discuss one of the topics which they value as being important in today's modern society. The event also served as a meeting where YPSSI members could evaluate the current state and plan the future of the network.

YPSSI is a European network set up with the aim of reconstructing the trust of young people in decision-making mechanisms, to foster their commitment to participation in public life and to empower them on knowledge and European issues. It is also the network's aim to provide an opportunity for young people to dialogue with leaders and to carry out coordinated actions across Europe. The network's activities includes meetings of young people, scientists and organizations who share the respective skills, knowledge and local experiences in order to build a democratic knowledge-based society and enhance the participatory process of decision-making.

With this in mind, six topics of importance in the achievement of sustainable development were discussed during the first few days of the event. The discussions took place just under the Acropolis at the Ionic Center at the centre of Athens. The sessions included the participation of 24 scientists with expertise in the following fields:

1. Climate Change
2. Energy generation and alternative technology
3. Innovative technologies including biofuels, nanotechnology and waste disposal
4. Food and Water production and availability
5. Biodiversity
6. Public Health

Solutions and actions required to manage the problems and issues identified as hindering the achievement of sustainable development featured as important aspect for the participants who also stressed the value of youth participation in decision making. Issues were raised on the concerns over nuclear power as an alternative to fossil fuel energy, the advantages and negative effects of biotechnology over conventional production practices, the management of water resources by governments and the effects of climate change.

The event continued with a one-day skills training session. The enhancement and empowerment of the youth through the development and enrichment of their skills was always one of the goals of the YPPSI network. For this reason, the British NGO "People and Planet" organized a training session for the young participants where they participated in an introductory course on the basic skills to strengthen and fulfil the network's objectives. These included:

1. Event organisation and planning
2. Lobbying, debate and PR skills
3. Network cohesion preservation, regular and productive flow of group dynamics
4. Creativity
5. Action planning
6. Group dynamics



During the last two days in Athens, the young Europeans were able to work together towards setting the priorities for the network. The structure of the network was also revised and reorganised such to facilitate the participation of all YPPSI members. These last sessions were also important for the network to set its milestones including those for future activities and events. The event concluded with the young participants presenting the outcomes of their discussions and training to Athenian scientists, academics and students. During this evening, the network was introduced to the public and the priority areas established were explained.

Ms Rosalie Camilleri is a post-graduate student following the MSc (Sustainable Development) at the Institute. She participated in this event and prepared this report.



18-20 May 2011 NECTAR 2011 Conference Smart Networks – Smooth Transport – Smiling People - University of Antwerp, Belgium

Dr Maria Attard presented a paper at the NECTAR 2011 conference entitled 'Critical success factors for reforming public transport systems: the case of Malta's bus service'.

NECTAR is the Network on European Communications and Transport Activities Research. At this conference Dr Attard was appointed committee member of Cluster 2 Policy and Environment alongside Prof. Harry Geerlings (Erasmus University, Netherlands), Prof. Edoardo Marucci (Universita' degli Studi di Rome 3, Italy) and Prof Yoram Shiftan (Technion, Israel).

23-30 May 2011 Quality of Life Pilot Questionnaire - Msida Campus, Malta

The Institute for Sustainable Development has worked in close collaboration with the Geography Division of the Mediterranean Institute, at the University of Malta and the Geography Department of Innsbruck University on a pilot questionnaire on Quality of Life of University Students. The Institute has on-going research through one of its Master's students, also participating in this pilot.

3 June 2011 TransNEW Project South Balkans and Mediterranean: Transport Research Capabilities and Potentials Workshop - Istanbul, Turkey

Dr Maria Attard was invited to present at a workshop organised by the University of Newcastle (UK) in collaboration with Tubitak (Turkey). Her presentation was entitled 'Research in Transport: the case of Malta'. TransNEW is a Support Action under the European Commission Seventh Framework (2007-2013) Theme TPT.2008.0

20-21 June 2011 IMAGINE 18 - Verdala Castle, Malta

IMAGINE 18 is an initiative by Government to support Malta's bid for European Capital of Culture (ECOC) for 2018. Academic staff from the Institute attended the meetings organised by the Valletta 2018 Foundation and contributed to the debates on the vision of 'cultures of sustainability' for Malta.

FP7 Information Sessions organised by the Malta Council for Science and Technology - Bighi, Malta

The Institute attended a number of FP7 information sessions at the MCST in Bighi to better understand the process and objectives of the various calls.

8 July 2011 InFLOWence Seminar - Valletta, Malta.

Ms Thérèse Bajada contributed to this seminar organised by the Fondazzjoni Temi Zammit (FTZ) with a presentation entitled 'Transport Systems in the Grand Harbour. The Case Study of Valletta'. The InFLOWence Seminar was held as part of an EU funded project of which FTZ are partners.

20-22 July 2011 11th International Conference for GeoComputation 2011 - London, UK

A team of interdisciplinary researchers namely, Ms Luana Chetcuti Zammit, Dr Kenneth Scerri, Dr Maria Attard, Ms Thérèse Bajada and Mr Mark Scerri, presented their work on 'Spatio-temporal analysis of air pollution data in Malta' at the 11th International Conference for GeoComputation which was held at University College London (UCL). The presentation was well received and the team was asked to submit the paper for review to a special journal issue of *Computers, Environment and Urban Systems*



7-13 August 2011 Summer School in Transportation - Helsinki, Finland

Ms Thérèse Bajada attended a Summer School on Transportation organised by Aalto University. The topics covered by the summer school included planning, plan and programme evaluation methods, financing of transport plans and issues of governance, service delivery and organisation in the transport sector. This summer school is part of the academic and professional development of Ms Bajada.

12 September 2011 TRANSit The Way Forward, Open Day - Msida Campus, Malta

Ms Thérèse Bajada contributed to this Open Day organised by the Fondazzjoni Temi Zammit (FTZ) with a presentation entitled 'Green Travel Plans - an opportunity for sustainable mobility' written in collaboration with Dr Maria Attard. The Open Day aimed at presenting the main objectives, final results and foreseen initiatives of the EU funded project named TRANSit - Mediterranean Intermodal Transit. In particular, the TRANSit project aims to set the foundations for the development, operation and promotion of a unified, integrated and innovative network for intermodal and multimodal logistic transport services. TRANSit is funded under the MED Operational Programme – Cohesion Policy 2007-2013.

Events

Public Lecture by Helen Lawton Smith, Professor of Entrepreneurship 11th March 2011 - University of Malta, Msida Campus

The Institute for Sustainable Development was pleased to host a public lecture by Dr Helen Lawton Smith, Professor of Entrepreneurship at Birkbeck College, University of London on the topics of Universities, technology transfer and local economic development. Her research focuses on studies of innovation and entrepreneurship in both high-tech and traditional sectors in the UK, Canada, France and Belgium with a particular interest in university-industry interaction. Professor Lawton Smith also holds positions as a Distinguished Research Associate at the Department of Geography at Oxford University, a Research Associate at the Centre for Business Research at Cambridge University, Founder and Management Director and Director of Research of the Oxfordshire Economic Observatory at Oxford University and Academician at the Academy of the Social Sciences.



Her talk attracted over 90 persons from a variety of sectors including researchers from a number of disciplines including enterprise, economics, management, geography, ICT, science and social sciences, Civil servants and private industry.

A Series of Public Lectures by Paul Longley, Professor of Geographic Information Science 13, 15 April 2011 - University of Malta, Msida Campus

The Institute for Sustainable Development was pleased to host Prof. Paul Longley as visiting lecturer for the academic year 2010-2011. During his stay Prof. Longley delivered two public lectures entitled *Ten Years of Geographic Information Systems and Science* and *Fractal Cities: Modelling Growth and Dynamics with New Digital Data Infrastructures*.



**Public Seminar Maltese Surnames: A local and international perspective
14th April 2011 - University of Malta, Valletta Campus**

The Institute for Sustainable Development organised a public seminar on the topic of Maltese Surnames bringing together local and foreign expertise.

Prof. Joseph Brincat from the Department of Italian at the Faculty of Arts of the University of Malta and Dr Mario Cassar who has recently completed his doctoral thesis on the subject made presentations about Maltese surnames.

Prof. Paul Longley from the Geography Department at UCL (London) and visiting professor at the Institute for Sustainable Development presented his work on world family names and the creation of databases where everyone can look up their surname and find people with the same family name around the world. The database now also contains information about Maltese surnames.

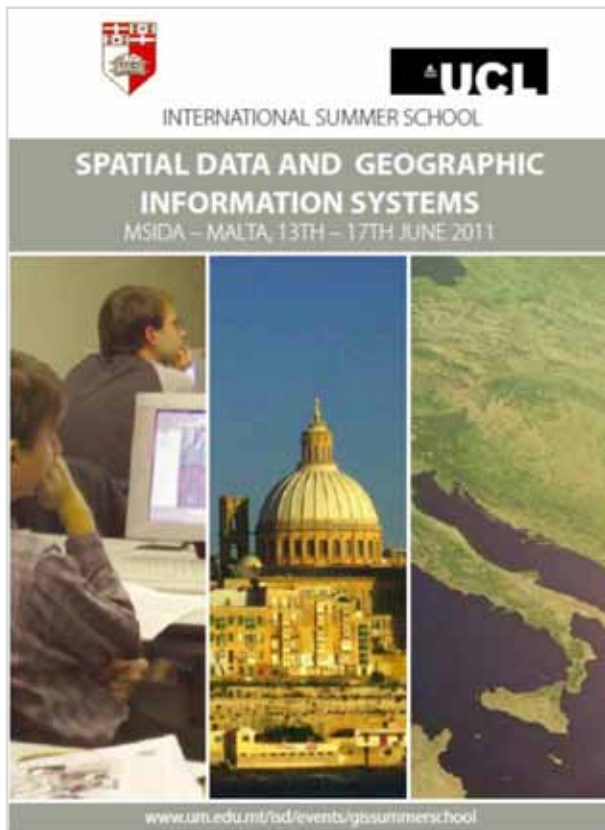
The Seminar was held in the new lecture halls at the Valletta Campus.



http://www.um.edu.mt/isd/notices/visiting_professor_at_isd
<http://worldnames.publicprofiler.org/>



International Summer School in Spatial Data and Geographic Information Systems 10th – 17th June 2011 – University of Malta, Msida Campus



This is the fourth in a series of Summer Schools on Geographic Information Systems (GIS) run by the Institute for Sustainable Development in collaboration with well-known international partners.

This year the University of Malta partnered with the Department of Civil, Environmental and Geomatic Engineering, University College London (UCL) to deliver a summer school specifically dedicated to Spatial Data and Geographic Information Systems. Dr Kate Jones from Portsmouth University was guest lecturer during the week long course.

The summer school attracted a variety of applicants with different backgrounds and different applications. Facility managers within Enemalta (Malta's energy providers) were most represented. Various departments with the Ministry for Resources and Rural Affairs were also present. Two participants hailed from the Land Transport Directorate of Transport Malta (the transport regulator in Malta). A number of independent researchers attended the summer school and researchers from the University of Trento made up the international component of this year's school.

The academic faculty was made up of Dr Maria Attard (UoM) and Dr Muki Haklay (UCL) as coordinators and Dr Claire Ellul (UCL) and Dr Helena Titheridge (UCL) contributing to the lectures. Dr Kate Jones (Portsmouth) was a guest lecturer and covered the content on geodemographics and spatial statistics. For the first time this year students were able to get a feel of complimentary technology for the collection of geographic data from the field. Students were equipped with GPS receivers and required to collect data which was then uploaded into the GIS software.



Overall the summer school was successful with a very good feedback received from the participants.

Research Activity

Transport Information Systems and Telematics (TISTA) Research Group

The setting up of a research group in this area was driven by academics at the University carrying out research in various aspects of transport including transport geography and policy, information systems to support transport infrastructures, communication systems, data processing and systems control in order to analyze and correlate large datasets. Through common interests this group seeks to integrate efforts to work towards common research projects with the objective to bring together different perspectives to the study of transport systems.

The group consists of an interdisciplinary mix of academics from the Institute for Sustainable Development, the Geography Division within the Mediterranean Institute, the Department of Systems Control and Engineering within the Faculty of Engineering and the Department of Communications & Computer Engineering, the Faculty of the Built Environment and the Department of Computer Information Systems from the Faculty of ICT.

The **objectives** of the group are:

1. To conduct interdisciplinary research in various aspects of transport information, systems and telematics related to transport.
2. To develop, integrate and coordinate research projects with similar objectives and purposes in order to use more efficiently the research resources within the various departments.
3. Through this integration coordinate efforts to propose research into specific aspects of transport and seek to establish the grounds for its implementation and commercialization potential.
4. Undertake to publish the research carried out by the group in a timely manner, both in paper as well as in oral formats in seminars, conferences and public lectures.
5. Through publication seeks to encourage more research into this area and engage the interest of students, post-graduate researchers and other various stakeholders within and outside the University.
6. Participate in various international fora (e.g. COST, TRB) dealing with the group's research interests and broaden the group's network of researchers and projects.

The research group is headed by Dr Maria Attard and functions under the auspices of the Institute for Sustainable Development, in itself an institute which fosters and encourages interdisciplinary research across many disciplines at the University. The Institute supports the work of the research group, maintains a dedicated website and from time to time organizes events to disseminate the work of the group.

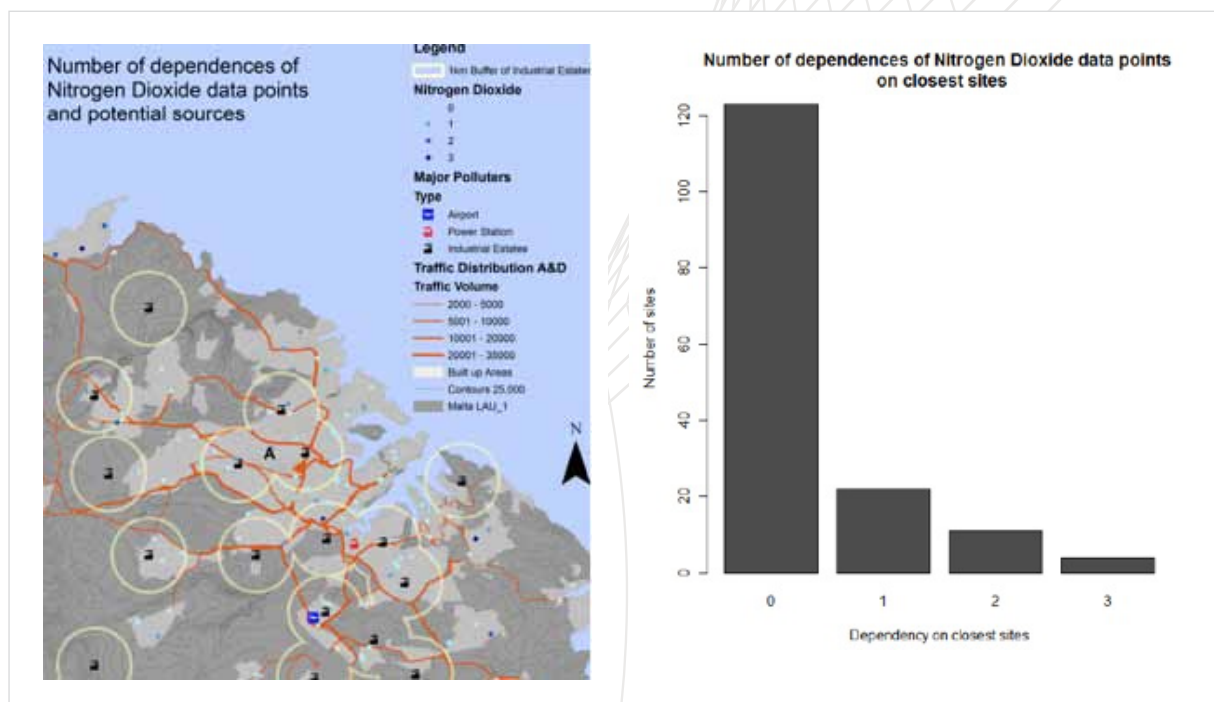


The research group has already presented some work at the 11th International Conference of GeoComputation in the summer of 2011 whilst TISTA research group members, Dr Ing. Adrian Muscat and Dr Ing. Saviour Zammit, supervised the following transport-related final year projects in 2011:

- Travel Information System;
- On Demand Public Transport System;
- Intelligent Campus Parking System.

Conference Proceedings

Chetcuti Zammit, L. Scerri, K., Attard, M., Bajada, T., Scerri, M. (2011) *Spatio-Temporal Analysis of Air Pollution Data in Malta. Paper presented at 11th International Conference of GeoComputation 2011, organised by the GeoComputation Community, University College London, UK, 20th – 22nd July.*



<http://www.um.edu.mt/isd/tista>

Entrepreneurship Unit

During the review period, the eUnit focused on finding and establishing opportunities for entrepreneurship at the University, but also reaching out to the community and establish contacts and potential sources of funding. The following activities were undertaken.

Meeting with the Malta Council for Science and Technology and Malta Enterprise

In November 2010 Dr Zammit and the Director of Corporate Research and Knowledge Transfer, Dr Anton Bartolo, participated in a three way meeting between the University of Malta, the Malta Council for Science and Technology and Malta Enterprise to discuss the commercialization of University research, and the support that these enterprises can provide to science, technology and media start-ups.

Investigating potential collaboration with the Edward De Bono Institute for the Design and Development of Thinking

In November, a meeting was held with the Edward Debono Institute for the Design & Development of Thinking to investigate how the two Institutes can collaborate on initiatives about entrepreneurship and innovation education. The eUnit co-ordinator explained the *raison d'être* of the eUnit, expounded his vision for the unit and proposed ways in which the two institutes can collaborate.

GetQualified Scheme Presentation

In December, Dr Zammit attended an information session held by Malta Enterprise at the University Council Room to explain the "Get Qualified" funding scheme. Following this information session the eUnit co-ordinator proposed the inclusion of the planned "Masters in Entrepreneurship" within this scheme and subsequent funding schemes.

Further Info Sessions

In January 2011, the eUnit coordinator attended a public consultation meeting delivered by the CIP National contact point entitled "The EU's Competitiveness & Innovation Framework Programme (CIP) 2011 and Public Consultation on the Future of CIPO". Furthermore in February, Dr Zammit attended the conference "Chemistry and Intellectual Property - Catalysing Innovation" organized by the University of Malta in collaboration with Malta Enterprise and The Malta Chamber of Commerce, Enterprise and Industry.

Extending the collaboration with Malta Enterprise

In February, a meeting was held between the eUnit Coordinator, the Director of Corporate Research and Knowledge Transfer and Samantha RUNCO, a consultant with the Research, Technology Development & Innovation Policy and Forward Planning Unit at Malta Enterprise, to discuss the funding of spin-offs and start-ups.

Setting up of a Business Angle Network

During April, the eUnit started work on the setting up of a Business Angle Network in collaboration with the Directorate of Corporate Research and Knowledge Transfer. A number of meetings were held with various interested parties to discuss seed capital for start-ups.

Worth noting was a meeting held with the Mr Louis John Vella, Hon. Consul General for San Francisco with jurisdiction over the State of California. The discussion focused on the opportunities for Maltese in the US to provide seed funding for University and the eUnit start-up companies. This initiative is expected to gather pace once the ESF funded training program commences in 2012.

Outcome of the ESF Application – Creating a Knowledge Transfer Framework and Technology Entrepreneurship Training Programme

On the 15th June the eUnit was formally informed that its joint-application with the Corporate Research and Knowledge Transfer office for ESF funding had been accepted by the Maltese authorities. Through these funds, the eUnit will develop an Intensive Training Programme, with the main objective being to increase the number of Science, Engineering, Technology and Media graduates with a professional grounding in entrepreneurship, and hence lead to an increase in Science and Technology start-ups in the Malta.



The specific objectives of the project are:

- to develop an intensive training programme in science and technology entrepreneurship at the University of Malta for delivery (i) as a virtual learning environment assisted, classroom based programme and, (ii) as a distance learning course;
- to deliver the intensive training programme twice, once in 2012 and 2013; and
- to build an ongoing postgraduate degree programme by re-using the intensive training programme modules.

The success in obtaining these funds is a critical milestone for the eUnit and will set the tone for its medium term plans, well into 2015.

Workshop on Funding Options for Research, Technology Development and Innovation (RTDI) – Providing a voice for SME's

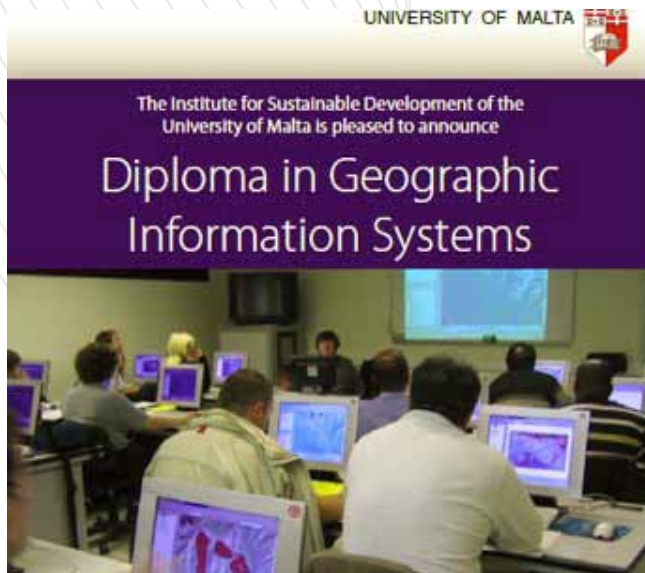
In September, the eUnit coordinator participated in this workshop organized by the Malta council for Science and Technology and the University of Ulster (UK). The challenges faced by SMEs were discussed, as well as the opportunities offered by the EU RTDI funding mechanisms. These funds would be available to young enterprises once they overcome the initial funding hurdle.

Involvement of the eUnit in TISTA

The eUnit co-ordinator joined the TISTA research group set up by the Institute and it is expected that the eUnit Masters programme will contribute substantially to the research efforts of this group.

The Institute's Study Programmes

The Diploma in Geographic Information Systems



The Diploma in Geographic Information Systems is the first opportunity for formal training for those interested in developing skills in this very specialised discipline. This is a part-time (evening) course over six semesters and falls under the Get Qualified funding scheme where students get financial support to undertake their studies.



YEAR ONE

- ISD1100 Basic Skills in Geographic Information Systems (Lab Practicals) 6 ECTS
- ISD1101 Basic Concepts of Geographic Information Systems 4 ECTS
- ISD1102 Introduction to Geographic Information 4 ECTS
- ISD1103 Introduction to Geographic Analysis 4 ECTS
- ISD1104 Introduction to Database Management Systems for GIS 4 ECTS
- ISD1105 Remote Sensing and Applications 4 ECTS
- ISD1106 Mobile Geographic Information Systems 4 ECTS

YEAR TWO

- ISD1203 Intermediate Skills in Geographic Information Systems (Lab Practicals) 6 ECTS
- CRM1001 Geographic Information Systems and Crime Mapping 4 ECTS
- ISD1200 Geovisualisation 4 ECTS
- ISD1201 Programmable Aspects of Geographic Information Systems 4 ECTS
- ISD1202 Cartography and Digital Mapping 4 ECTS
- ISD1204 Geographic Information Systems and GeoDemographics 4 ECTS
- ISD2205 Geographic Information Systems and Databases 4 ECTS

YEAR THREE

- ISD2000 Long Essay 8 ECTS
- ISD2305 Advanced Skills in Geographic Information Systems (Lab Practicals) 6 ECTS
- ISD2301 Web Mapping 4 ECTS
- ISD2302 Geographic Information Systems in Transportation 4 ECTS
- ISD2303 Managing Geographic Information Systems 4 ECTS
- ISD2304 Advanced Geographic Analysis and Mapping 4 ECTS

Due to the low number of applicants the Diploma was not opened in October 2010.

The Diploma in Sustainable Land and Real Estate Management

The Diploma in Sustainable Land and Real Estate Management is an interdisciplinary study programme bringing together the main aspects related to land and estate management. The study programme is designed in such a manner as to effectively develop skills and knowledge required by land managers to understand the complexities of rural and urban management and development. The study programme includes a number of study units aimed at the teaching of basic concepts of economics, law, geography, environment, finance, planning, management, architecture, marketing, ICT tools and statistics. This is a part-time (evening) over six semesters.



YEAR ONE

- CVL110 Law of Ownership and Property Law Relating to Sustainable Estate Management 4 ECTS
- MGT1013 Fundamentals of Management 4 ECTS
- ISD1110 Principles of Sustainability 6 ECTS
- ECN1003 Introductory Economics for Land and Real Estate Management 4 ECTS
- GEO1042 Socio-geographic Aspects of Land Management 4 ECTS
- ISD1108 Geographic Information Systems for Land Management 4 ECTS
- ISD1109 Quantitative Techniques for Land Management 4 ECTS

YEAR TWO

- CVL1109 Legal Anthropological Perspectives on Land, Property and the Environment 4 ECTS
- GEO1041 Urban and Rural Geography 4 ECTS
- RFS1400 Rural Policy and Land Use Management 6 ECTS
- EMP1201 Impact Assessment and Monitoring 4 ECTS
- LIN1063 Academic Reading and Writing in English 2 ECTS
- MRK1011 Introduction to the Marketing Concepts 6 ECTS
- SPI1011 Development and Spatial Planning 4 ECTS

YEAR THREE

- BKF2200 Real Estate Finance 4 ECTS
- CIS1043 Information Systems for Land Management 4 ECTS
- CNM1041 Property Valuation 4 ECTS
- ERL1000 Principles of Environmental and Development Planning Law in relation to Estate Management 4 ECTS
- MGT1052 Leadership and People Management 4 ECTS
- ISD1205 Project 10 ECTS



The Postgraduate Certificate in Geographic Information Systems

The Postgraduate Certificate in Geographic Information Systems covers the principles of the Geographic Information Science, such as spatial databases, programming, remote sensing and digital cartography and the technology supporting Geographic Information Systems such as principles, management and applications. It is a part-time (evening) course over two semesters.



YEAR ONE

ISD5001 Principles of Geographic Information Systems 5 ECTS

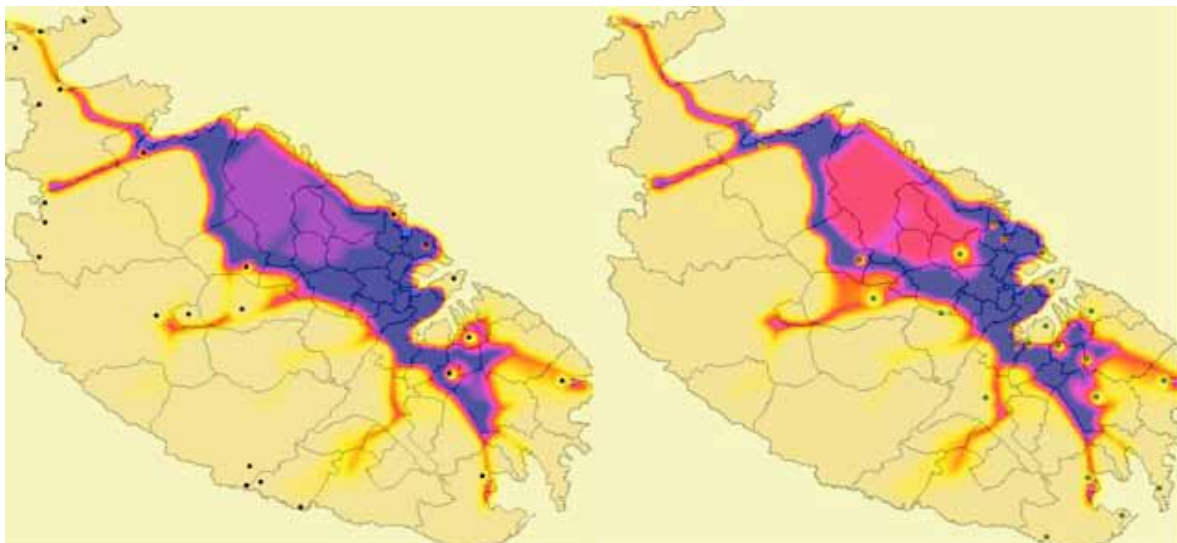
ISD5002 GIS and Databases 5 ECTS

ISD5003 Applying GIS (Lab Practicals) 5 ECTS

ISD5004 Geographic Information, Remote Sensing and Digital Cartography 5 ECTS

ISD5005 Managing Geographic Information Systems 5 ECTS

ISD5006 Programming in GIS 5 ECTS



The Master of Science by Research (Sustainable Development)

The Master of Science (Sustainable Development) is a research programme enabling researchers to focus on a variety of topics to be studied in depth through full-time or part-time study. The study programme is over three semesters or equivalent in part-time.

YEAR ONE

ISD5100 Dissertation 80ECTS

ISD5101 Research Methods 5ECTS

ISD5102 Principles of Sustainability 5ECTS

Student Intake 2010-2011

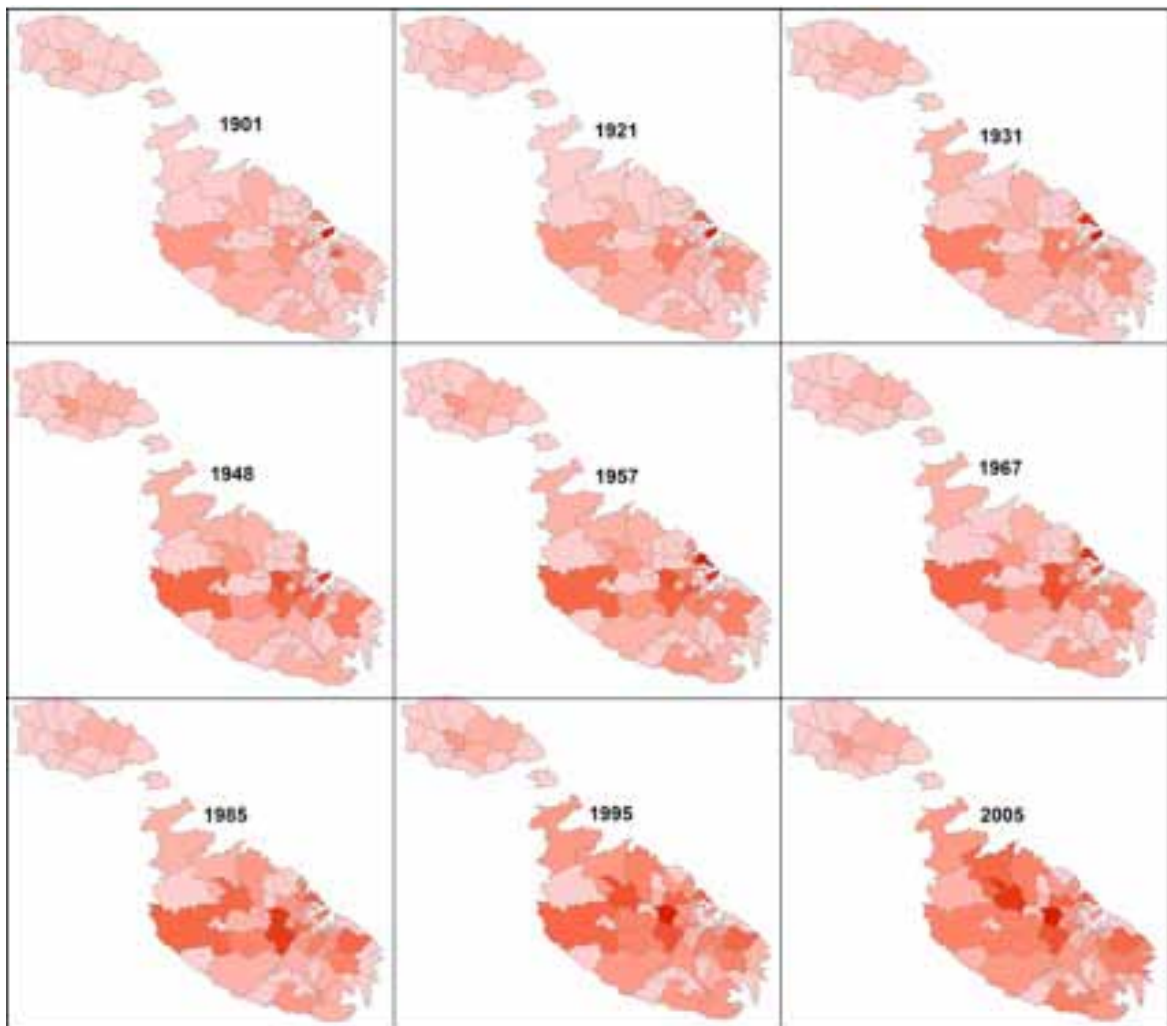
Student	Dissertation Title
Mr Andrea Pace (Full-time)	Modelling Education and Health Indicators and Malta's Urban Development Densities using GIS Supervisor: Dr Maria Attard
Ms Annalise Farrugia (Part-time)	Towards sustainable development in the Maltese Islands: Using GIS to manage air quality Supervisor: Dr Maria Attard
Ms Rosalie Camilleri (Part-time)	Ozone in the Troposphere: A study of the secondary pollutant in the Maltese Islands. Supervisor: Dr Emanuel Sinagra Co-supervisor: Dr Maria Attard
Ms Jacqueline Gatt (Full-time)	The geographic socio-economic distribution and its effects on student success in Malta Supervisor: Prof. Ronald Sultana Co-supervisor: Dr Maria Attard

Projects

WebGIS Project

The aim of the WebGIS project is to facilitate the availability of free geographic information about Malta. The major challenges faced this year have been the development of the base data and the definition of an appropriate coordinate system for the data.

The Institute hosted two interns from Spain during the period April to September 2011 to assist in this project. The two interns, Carlos Cañas Sanz and Jose Louis Bermejo from the Universidad de Alcalá were supported by the Erasmus Mobility programme and contributed heavily to the project by compiling data and creating the metadata. Annex 1 lists the datasets created over the past year. It is the aim of the Institute to make these datasets available to the public as quickly as possible when all the reviews and checks are made to ensure a high standard of quality in the provision of this information.



Interactive Map of the UoM Campus

Work on this project has been extended to include also the Communications and Alumni Office and the IT Services at the University. Over the past year the digital map of the campus has been updated with the most detailed information. It has been refined in terms of topographic detail and extended beyond the boundaries of the University to include surrounding areas.

IT Services are now developing the web tool for the interactive map which will be uploaded on the UoM website for public use.



Spatio-temporal analysis of air pollution levels in Malta

Research Partners: Faculty of Engineering (Dr Kenneth Scerri, Ms Luana Chetcuti Zammit), Institute for Sustainable Development (Dr Maria Attard; Ms Thérèse Bajada) and the Malta Environment and Planning Authority (Mr Mark Scerri).

This project has continued over the past year with some major successes. A presentation about the work carried out by the team was made by Ms Luana Chetcuti Zammit at the 11th International Conference for Geocomputation at UCL in London in July 2011. The presentation was well received and the team has been asked to prepare the paper for review in a special issue of the journal Computers, Environment and Urban Systems.

The extended abstract published in the conference proceedings is available in Annex 2.



Assessment of key success indicators for the Public Transport Reform in Malta

Agreement reached between the Institute for Sustainable Development and Transport Malta

The project aims to collect information about success indicators for public transport and analyse their progress over a period of five years. Key indicators include emissions, travel time, bus journey time and reliability and customer perception of the bus service. This project will see the Institute carry out surveys throughout the five year period and produce reports analysing the data and comparing them temporally. This project will also be complemented with student research and publications.



Development of an e-skills demand and supply monitor

Agreement reached between the Institute for Sustainable Development, E-cubed Consultants (Malta) and INSEAD eLab (France)

The Institute is supporting the development of an e-skills demand and supply monitor. A project which has been commissioned by MITA (Malta Information Technology Agency) to INSEAD eLab, and is being developed in consultation with the Institute and E-cubed consultants in Malta.

Travelling Smart – The Green Travel Plan Committee at the University of Malta

Dr Maria Attard chairs the Green Travel Plan (GTP) Committee with the aim of implementing the Green Travel Plan which Institute for Sustainable Development completed in 2010 and the University presented to the Malta Environment and Planning Authority and Transport Malta earlier on in 2011.

The Committee has now the task of establishing the role of the GTP coordinator and discuss issues related to the implementation of the GTP measures. Its remit is to meet every six months to discuss progress and problems encountered. It will also be in charge of monitoring the effectiveness of measures as they are implemented.

The GTP Committee is made up of
Dr Maria Attard (chair)
Perit Christopher Spiteri (Director, Estate and Works)
Mr Joseph Camilleri (Precincts Officer)
Ms Nathalie Cauchi (UHM)
Mr Henry Aquilina (Office of Human Resources)
Mr Stefan Balzan (President, KSU)
Prof. Luciano Mule Stagno (UMASA)
Ms Thérèse Bajada (travel plan expert, ISD)
Ms Stephanie Stellini (secretary)



www.um.edu.mt/isd/greentravel



Other Initiatives

Participation in COST

In the period under review, Dr Maria Attard was appointed Domain Committee member of the Transport and Urban Development (TUD) Domain within COST.



TUD fosters research coordination in the fields of transport and the built environment. It is cross-sectoral and multi-disciplinary, encompassing a wide range of scientific expertise within the transport and land use planning, design and management activities with a special emphasis on the strong interrelationships among the relevant policy fields as well as on all aspects related to sustainable development.

Dr Maria Attard and Dr Vincent Buhagiar (Faculty of the Built Environment) are members of a COST Action TU0803 Cities Regrowing Smaller - Fostering Knowledge on Regeneration Strategies in Shrinking Cities Across Europe (2009-2013).

Joint Programming Initiative Urban Europe

Over the past year the Institute for Sustainable Development has been following with interest the development of the JPI Urban Europe. It has attended all its public conferences and workshops and has been collaborating with Transport Malta, represented on the Governing Board of the JPI on the role of Malta in this initiative.

Dr Maria Attard has been recommended for appointment on the Scientific Advisory Board of this JPI. The selection procedures are to be held later in 2011.



Staff Publications for 2011

1. **Attard, M.**, Schembri, J.A. forthcoming Malta: GIS and Geography Teaching in the Context of Educational Reform. In *International Perspectives on Teaching and Learning with GIS in Secondary Schools*. Springer.
2. **Attard, M.** (2011) A preliminary assessment of the Park and Ride Scheme in Floriana, Malta. In Borg, R.P. et al. (eds) *Sustainable Development: Civil Engineering and the Built Environment*. Proceedings of an International Conference, Malta.
3. **Attard, M.**, Enoch, M.P. (2011) The role of policy transfer in the introduction of road pricing in Valletta, Malta. *Transport Policy*. Vol. 8/2 pp 544-553.
4. **Bajada, T., Attard, M.** (2011) Using GIS as a tool to improve road safety. In Borg, R.P. et al. (eds) *Sustainable Development: Civil Engineering and the Built Environment*. Proceedings of an International Conference. Malta.
5. Cilia, J., Merz, K.D., Griscti, D., **Zammit, S.**, Apap, M. (2010) *The Development of an Electric Drive using the Intelligent battery concept*. EVS25, 25th World Battery, Hybrid and Fuel Cell Electric Vehicles Symposium, Shenzhen, China, November.
6. Valentino, G., **Zammit, S.** (2011) *A technique for automatically reprogramming an embedded Linux system*. EUROCON - International Conference on Computer as a Tool (EUROCON), 2011 IEEE, pp.1-4, 27-29 April.
7. Vella, J.M., **Zammit, S.** (2011) *Infrastructure-Dependent Wireless Multicast over 802.11n WLAN*. SoftCOM 2011, 19th International Conference on Software Telecommunications and Computer Networks, Split - Hvar - Dubrovnik, September 15-17.
8. **Zammit, S.**, Valentino, G. (2010) *Design and Implementation of an Intelligent USB Peripheral Controller*. WICT 2010, November.
9. **Zammit, S.**, Trapani, S. (2010) *An Online High Quality Audio and Music Library*. WICT 2010, November.
10. **Zammit, S.**, Muscat, A., Gauci, G. (2010) *Remote Processing of an Interactive Application*. WICT 2010, November
11. Muscat, A., **Zammit, S.**, Attard, T. (2010) *An Autonomous Cognitive Personal Mobile Phone for Distributed Radio Access Cost Optimization*. WICT 2010, November

Annex 1

WEBGIS Project

Goal: To extract information from the different NSO census through the years, for spatio-temporal research

List of the created geographic data:

Population

(Map1) Selected criteria for the distribution of population, population density and dwellings by district, 1995-2005

Overview of total population by district, 1901 - 2005

Overview of total population by locality, 1901 - 2005

Population density by locality and citizenship, 1985

Population density by locality, 1995-2005

Total population by sex and district.1995-2005 Censuses

Total population by sex and locality.1995-2005 Censuses

Total population by type of citizenship, sex and locality.1995-2005

Births

(2009) Number and rate of total live births, by residence of parents

Deaths

(2009) Deaths by locality

Crime

(2003-2009) Reported crime by district

Dwellings

(Map1) Selected criteria for the distribution of population, population density and dwellings by district, 1995

(Map3) Percentage distribution of dwelling stock by type and by district 1995

(Map3) Percentage distribution of dwelling stock by type and by district 1995-2005

(Map4) Percentage distribution of VACANT dwelling stock by type and district, 1995

Occupancy status by district, 1995-2005

Occupancy status by locality, 1967 (changes in the stock of private dwellings)

Occupancy status by locality, 1985 (changes in the stock of private dwellings)

Occupancy status by locality, 1995-2005

Occupied dwellings by type of tenancy and district 1995-2005

Occupied dwellings by type of tenancy and locality 1995-2005

Percentage distribution of dwelling stock by type and by district, and for Malta , Gozo and the Maltese Islands, 1995

Private households by type of dwelling and locality (1995)

Type of tenancy 1995 (Dwellings by type of ownership 1995)

Type of dwelling (1995) (Private dwellings stock by occupancy, type and locality)

Type of dwelling 1985

Type of dwelling 1995-2005 by district (1995 Private dwellings stock by occupancy, type and locality)

Type of dwelling 1995-2005 by locality (1995 Private dwellings stock by occupancy, type and locality)

Households

(2008) Annual household consumption expenditure by district

(2008) Distribution of households by household net income octiles and district

(2008) Distribution of households in households by district and labour status

(2005) Private households by household composition and district

Cattle, pigs, sheep survey

(2009) Cattle population

(2009) Distribution of cattle population by age and sex

(2009) Distribution of farms and cattle by type of farm

(2010) Distribution of cattle population by age and sex

(2010) Distribution of farms and cattle by type of farm

(2009) Pig farms and pig population

(2009) Swine stock by type and district

(2009) Sheep-goat population

ICT survey

Computer access total and percentage

Schools

(2006) Number of schools by level of education, sector and district

(2006) Number of schools by level of education, sector and locality

Traffic accidents

2011 Q1_traffic accidents

Vehicles

(2008) Stock of licensed vehicles as at end of year by vehicle group and region

(2009) Stock of licensed vehicles as at end of year by vehicle group and region

Internal Migration

Internal Migration 2001-2005

Matriculation Examinations

Matriculation_by_Council

Matriculation_by_Region

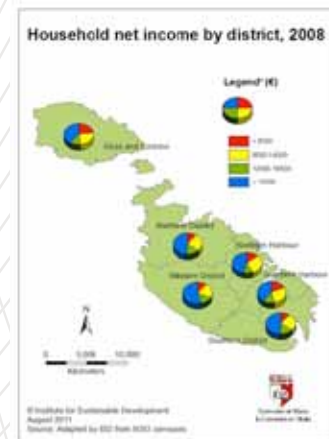
Total Registrations of Matriculation Certificate Candidates by Council

Total Registrations of Matriculation Certificate candidates by Region

SEC Examination

Total Registrations of SEC candidates by Council

Total Registrations of SEC candidates by Region



Historical maps

Goal: To create historical maps of Malta.

List of the created geographic data:

Coastal defences

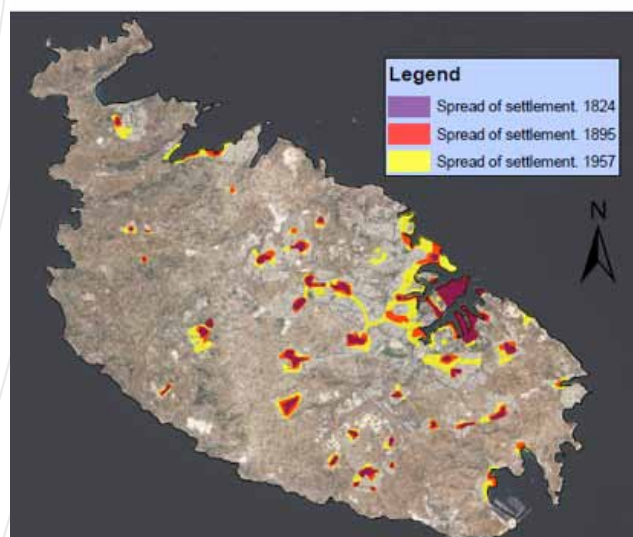
Spread of Settlement 1824

Spread of Settlement 1895

Spread of Settlement 1957

Spread of Settlement 2000

Villages before 1419



Campus map

Goal: To create a map of the UOM campus to support the development of an interactive map which is web-based and can be uploaded on the public website of the University.

List of the created geographic data:

- Buildings
- Bus stops
- Carparks
- Computer Laboratories
- Fountains / Water bodies
- Gardens / Green Areas
- Gates / Doors
- Information Points
- Landmarks
- Parking
- Passageways / Disabled Access
- Roads
- Sports Facilities / Areas
- Stairs
- Vehicle Access
- Wireless Access Points

Valletta Project

Goal: To create geographic information about the uses of buildings in Valletta

List of the created geographic data:

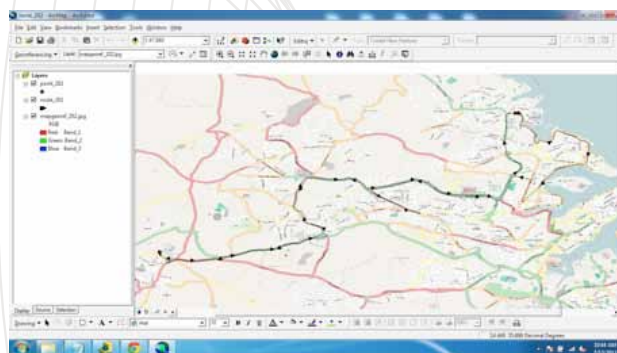
- Borders
- Land Use

ARRIVA NEW BUS SERVICE

Goal: Digitalization of the new bus routes that have a bus stop at the University of Malta

List of the created geographic data:

- Bus route 22
- Bus route 31
- Bus route 32
- Bus route 106
- Bus route 110
- Bus route 112
- Bus route 123
- Bus route 125
- Bus route 202
- Bus route X1
- Bus route X2



Post Code Project

Goal: To create a GIS of the Maltese post codes (sample localities)

List of the created geographic data:

- ATTARD
- BALZAN_LIJA (partial)
- SLIEMA (partial)

Annex 2

Spatio-Temporal Analysis of Air Pollution Data in Malta

Ms Luana Chetcuti Zammit¹, Dr Kenneth Scerri¹, Dr Maria Attard², Ms Thérèse Bajada³, Mr Mark Scerri⁴

¹Systems and Control Engineering Department, Room 419, Engineering Building,
University of Malta, MSD2080, Malta.
Tel: +356 2340 2080
E-mail: lche0003@um.edu.mt; kenneth.scerri@um.edu.mt

²Geography Department, University of Malta, OH132, University of Malta,
Msida MSD2080, Malta.
Tel: +356 2340 2147
E-mail: maria.attard@um.edu.mt

³Institute for Sustainable Development, First Floor, Regional Building, Triq l-Imħallef Paolo Debono,
University of Malta, MSIDA MSD2033, Malta.
Tel: +356 2340 3404
E-mail: therese.bajada@um.edu.mt

⁴Malta Environment and Planning Authority, Unit D2, Environment Protection Directorate,
PO Box 200, Marsa MRS1000, Malta.
Tel: +356 2290 7204
E-mail mark.scerri@mepa.org.mt

1. Introduction

Air pollution measurements display patterns over space and time allowing for spatio-temporal modelling, through which pollution concentrations and trends can be analysed. In Malta, the MEPA (Malta Environment and Planning Authority) collects monthly averaged data for sulphur dioxide, nitrogen dioxide, ozone and benzene from a network of 123 diffusion tubes located around the Islands (Figure 1). This preliminary study uses data for nitrogen dioxide (NO₂) and benzene collected monthly between the period 2004 and 2010 with the objectives to i) develop a computationally efficient model that best describes the data; ii) determine the level of dependence of each site on neighbouring ones and iii) identify any factors that affect the behaviour and patterns of pollution. Results will show that generally there is a low spatial dependence between closely located sites, thus implying that local sources, rather than diffusion, have a predominant effect on the measurements.

2. The case study - Malta

Malta is located in the centre of the Mediterranean Sea at approximately 100 kilometres south of Sicily. The archipelago consists of three main islands with a population over 400,000. The climate is typically Mediterranean with dry hot summers and mild rainy winters.

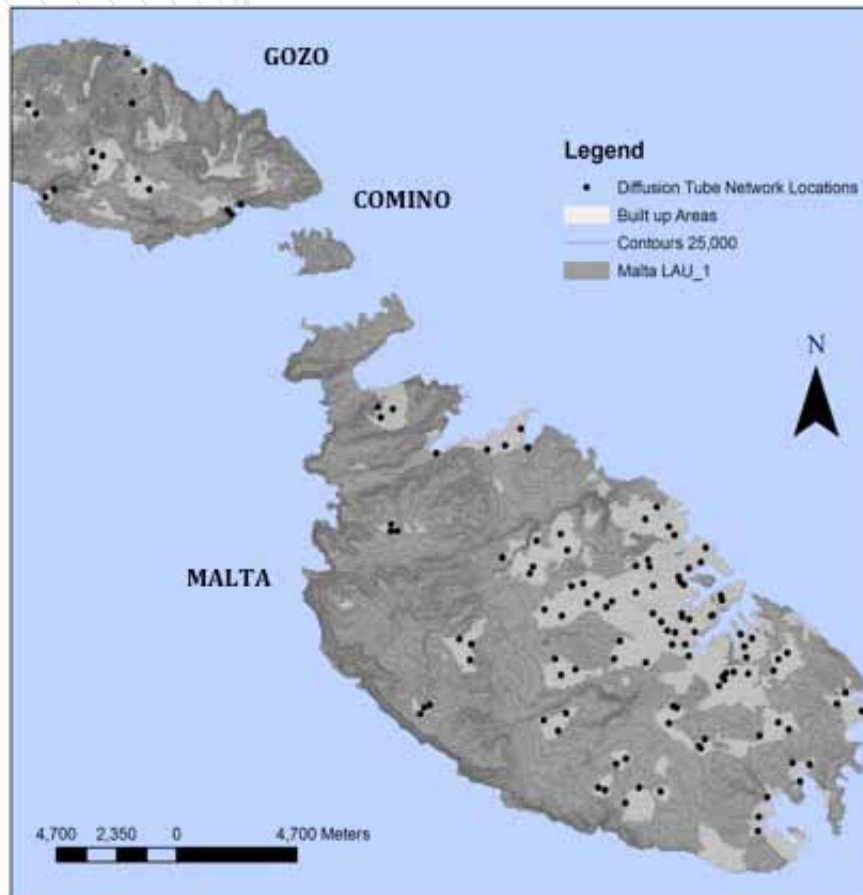


Figure 1. Location of Passive Diffusion Tubes (drawn by author)

Malta's development, reflected in its land use, increasing tourism and changing lifestyles, is happening very rapidly. This is making the islands environmentally vulnerable mainly due to the high population density and limited carrying capacity. The major environmental concern in Malta relates to air quality (Government of Malta 2002, Office of the Prime Minister 2010). The main contributors to air pollution are the high demands for energy generation and the growth in private car use. Electricity is generated from the combustion of fuel oil at two power stations. In addition, the islands were home to 229,016 private vehicles in 2009 (NSO 2009b), one of the highest car ownership rates in the world. These have increased the risks of atmospheric pollution particularly by carbon monoxide, oxides of nitrogen, volatile organic compounds and particulate matter (MEPA 2010).

The complexity is increased by the fact that air pollution generated locally can have an impact on a regional scale. Contaminants disperse through the atmosphere and industrial activities in one place can affect the air quality in another.

3. Data Analysis and Validation

Data-driven modelling strategies (Ljung 1999) are applied in this research to study the dependencies between readings taken at different sites. In particular, statistical multivariate or Vector AutoRegressive (VAR) models are used to represent the spatio-temporal relationships in the data. These methods were first proposed for the study of such phenomena by Pfeifer and Deutsch (1980a,b).

Seasonal and temporal trends in the data were eliminated so as to identify dependencies among sites rather than correlations due to these trends. Detrending was performed by differencing (Chatfield 2004) and the stationary time series obtained were modelled by VAR(p,q) models. Due to the large number of parameters to estimate from the limited data, the method in De Luna and Genton (2005) was adopted. This method limits the number of parameters to estimate, by estimating only the statistically significant coefficients while setting the others to zero. Note that, to the authors' knowledge these methods have only been applied to datasets with a small number of observation sites (usually less than 10), while in this work the flexibility of this method to higher dimension problems (123 sites) is being tested. Note that the predictive accuracy of the models obtained has been tested by a validation dataset not used in the estimation procedure. Using this dataset, the one step ahead residues after modelling were found to be temporally white up to a confidence interval of 88% for benzene and 91% for NO₂.

4. Conclusions

The results obtained indicate that the dependencies in the predictions are limited at most to the three closest neighbours for each site. Figures 2 and 3 show the number of dependent sites for each location for the pollutants under consideration. Thus a value of 0 indicates that the reading at that particular site is only dependent on previous readings at the same site, while a value of 1 indicates that the measurements are dependent on the site itself and also its first closest neighbour, and so on for the other values.

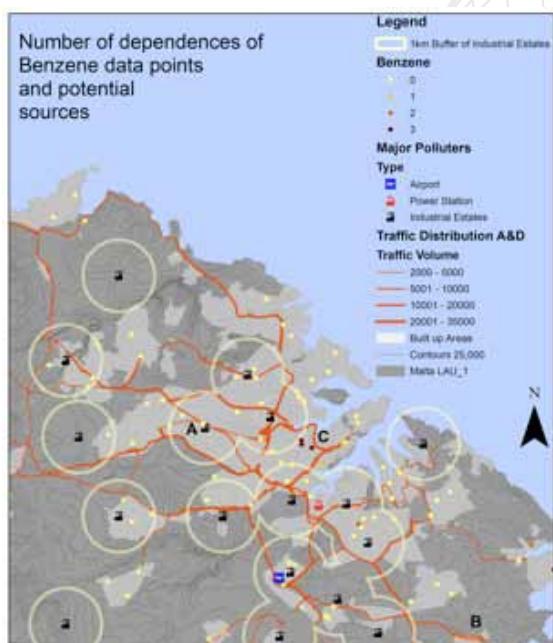


Figure 2. Benzene (drawn by author)

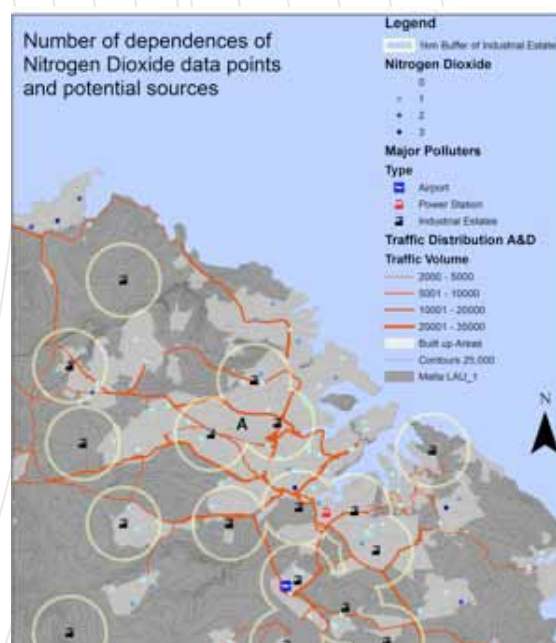


Figure 3. NO₂ (drawn by author)

The following interpretations of the results in Figures 2 and 3 are carried out based on the assumption that the climate is homogenous throughout the area under study, a reasonable assumption for Malta. Also, note that only dependence over a temporal resolution of 1 month is being investigated and thus either shorter or longer term dependencies cannot be ruled out.

The assumption that dispersal of pollutants is equidistant and therefore one source of pollution in one area has an effect on the neighbouring areas is not supported here. This is further demonstrated by the overlaying of potential sources of pollution in the main island such as traffic density, industrial estates, power stations and the airport. Notwithstanding that most of the points are located relatively close to each other and to these sources, most readings seem to be independent.

The overall spatially independent behaviour of these pollutants would suggest that there are other, more local factors that are affecting air pollution. Some possible interpretations follow.

- Since there is input from a stable source (e.g. traffic) similar temporal patterns can be observed. However, at another location, the source input levels may change (for example, less traffic) and therefore the behaviour of that point, even though it is relatively close, is independent. This is most evident in the area northwest of the Grand Harbour (marked A in Figures 2 and 3). This is reasonable since in the Maltese urban environment the urban density, urban fabric and traffic change considerably over a relatively short distance.
- A few points experience higher spatial dependencies. These are marked with the letters B and C in Figures 2 and 3. In these cases we note that (i) the pollution values at some of these locations are relatively low, thus affecting the accuracy of the modelling procedure (area marked B) (ii) there are very similar environmental conditions (traffic and urban density) affecting the sites (area marked C).
- These results are validated by MEPA's approach adopted for the location of diffusion tubes. MEPA selects two to three sites per locality, one of which is a traffic site and the other/others are background sites (without traffic).

MEPA is currently undergoing a redistribution exercise of the diffusion tube network. This analysis will prove valuable to determine which sites are necessary to retain and which sites are redundant and can be removed. Future work will focus on introducing measured pollution sources to the mathematical model to verify the dependence of the pollution readings on these sources.

5. Acknowledgements

The research work disclosed in this abstract is funded by the Malta Government Scholarship Scheme (MGSS).

6. References

- Chatfield C, 2004, *The Analysis of Time Series*. Chapman & Hall / CRC, USA.
- De Luna X and Genton MG, 2005, Predictive Spatio-Temporal Models for spatially sparse environmental data. *Statistica Sinica*, 15:547-568. Available online at <http://www3.umu.se/stat/personal/xavier.deluna/papers/stpredict.pdf>. Last accessed 20 January 2011.
- Government of Malta, 2002a, Johannesburg Summit 2002, Malta Country Profile.
- Ljung L, 1999, *System Identification – Theory For the User*. Prentice Hall, USA.
- MEPA, 2010, *Air: Sources and Effects*. Malta Environment and Planning Authority, Malta. Available online at <http://www.mepa.org.mt/air-sources>. Last accessed 15 October 2010.
- NSO, 2009a, *Malta in Figures 2009*. National Statistics Office, Malta. Available online at <http://www.mepa.org>.

mt/air-publications. Last accessed 15 January 2011.

NSO, 2009b, *Motor Vehicles: Q4/2009* News Release. 20 January 2010. 008/2010. Available online at <http://www.nso.gov.mt/statdoc/documentfile.aspx?id=2669>. Last accessed 15 January 2011.

Office of the Prime Minister, 2010, *Air Quality Plan for the Maltese Islands*. Prepared by the Malta Environment and Planning Authority, Floriana, Malta. Available online at <http://www.mepa.org.mt/air-publications>. Last accessed 5 January 2011.

Pfeifer PE and Deutsch SJ, 1980a, A three-stage iterative procedure for space-time modeling. *Technometrics* 22(1): 35-47.

Pfeifer PE and Deutsch SJ, 1980b, Identification and Interpretation of First-Order Space-Time ARMA Models. *Technometrics*, 22(3): 397-403.