

TRACK 3 - ENVIRONMENTAL COMPUTING AND ENVIRONMENTAL ENGINEERING

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2.	A Simulation Study on the Impacts of Different Rainfall Scenarios on the Effectiveness of the Flood Control Structures of Mandulog River, Iligan City, Philippines	Sheila N. Frias*, Peter D. Suson, Daniel S. Mostrales, and Alan E. Milano College of Engineering & Technology, Mindanao State University-Iligan Institute of Technology, Iligan City, Philippines *frias.sheila123@gmail.com
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4.	An Information Communications Technology (ICT)-Based Awareness Framework for Air Pollution Level In Urban Cities	Ernesto E. Empig* and Nerico L. Mingoc School of Computer Studies, Mindanao State University - Iligan Institute of Technology, Tibanga, Iligan City, Philippines *ernesto.empig@g.msuiit.edu.ph
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10.	Development of Smart Urban Gardening System for Sustainable Consumption and Production: An Internet of Thing Application	Allan P. Bicada*, Ernesto E. Empig, Venus R. Parmisana, and Joel I. Miano Mindanao State University – Iligan Institute of Technology, Iligan City, Philippines *allan.bicada@g.msuiit.edu.ph
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17.	Microcontroller-Based Potable Water Monitoring System with SMS Notification	Joel I. Miano, Ofelia S. Mendoza*, Glaiza May L. Ganob, Risha Mae J. Zaragoza, Ma. Kristilyn P. Cabahug, Ian James R. Bagunas, and Alexander R. Gaw Mindanao State University – Iligan Institute of Technology, Iligan City, Philippines *ofelia.mendoza@g.msuiit.edu.ph
18.	Modelling Runoff Using Different Artificial Neural Network Methods and Multiple Linear Regression	Ibrahim Yurtseven ¹ and Miraç Aydin ^{*2} ¹ Istanbul University, Faculty of Forestry, Department of Watershed Management, 34473 Bahcekoy-Istanbul, Turkey ² Kastamonu University, Faculty of Forestry, Department of Watershed Management, Kuzeykent-Katamonu, Turkey *aydinmirac@hotmail.com
19.	Production and Evaluation of Red Clay-based Slip Casted Water Filter	Ephraim E. Ibarra* and Paul Zoren M. Megalbio Mindanao State University – Iligan Institute of Technology, Iligan City, Philippines *ephraim.ibarra@g.msuiit.edu.ph

20.	Relative Accuracy of Flood Modeling using LiDAR Data and Coarser Resolution Elevation Datasets	Stephanie Mae B. Salcedo*, Daniel S. Mostrales, Jennifer G. Blasco and Alan E. Milano College of Engineering & Technology, MSU-Iligan Institute of Technology, Iligan City, Philippines *stephaniemae.salcedo@g.msuiit.edu.ph
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23.	Suitability Mapping of Key Crop Commodities in Misamis Occidental	Wilfredo Uy ^{1,2} , Venus Leopardas ^{1,2} , Lovely Parungao ³ , Jerico Consolacion ^{4*} , Garry Marapao ⁴ and Hessed Cabanilla ¹ ¹ Institute of Fisheries Research and Development, Mindanao State University – Naawan, Misamis Oriental, Philippines ² College of Science and Environment, Mindanao State University-Naawan, Misamis Oriental, Philippines ³ College of Education and Social Studies, Mindanao State University-Naawan, Misamis Oriental, Philippines ⁴ College of Agriculture and Forestry, Mindanao State University-Naawan, Misamis Oriental, Philippines *jericoconsolacion27@gmail.com

ABSTRACTS

OFF AND FLOODING INSIDE THE ILIGAN RIVER BASIN

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This study aims to demonstrate the importance of adopting a sound land use management to mitigate flooding. This was done by comparing a desired land use to a projected land cover scenario in 2026. The projected land cover simulates what happens to the land cover of the Iligan River Basin in 2026 when there is no intervention involved given past land cover data. The comparison between the two-land use/cover conditions is in terms on run-off and flooding. For the run-off results, the Projected Land Cover has a higher total runoff volume, peak flow and shorter Lag time as compared to the Desired Land Use given four (4) rainfall scenarios. That is because the Desired Land Use has more forest vegetation than the projected land cover and has better forest cover quality. Such condition helps improve soil infiltration and thus reduces runoff volume and peak time. The result also shows that the effect on flooding by Projected Land Cover shows more areas have been flooded and with higher flood depth level as compared to the Desired Land Use in the same rainfall scenarios. That is expected because of the high runoff volume in the projected land cover than in the desired land use since runoff is the major source for flood. The study shows when land cover conditions are left by itself without any intervention, flooding is more likely to be magnified. The study also shows that flood can be mitigated if the Desired Land Use scenario will be adopted.

Keywords: *Flooding, Runoff, Land Cover and Land Use*

A SIMULATION STUDY ON THE IMPACTS OF DIFFERENT RAINFALL SCENARIOS ON THE EFFECTIVENESS OF THE FLOOD CONTROL STRUCTURES OF MANDULOG RIVER, ILIGAN CITY, PHILIPPINES

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Widespread news coverage of the flood disaster brought by Tropical Storm Washi (Sendong) highlighted the destruction it brought to Iligan City, Philippines. This study aims to assess the effectiveness of the levee in the event of a 50-year and 100-year rainfall scenario in terms of the flooded barangays. It is expected to have a decrease in the inundated area with the presence of the levee for both rainfall scenarios. Using the ArcGIS software ArcMap 10.2, the affected barangays were extracted by overlaying the floodplain area on the Iligan City barangay boundaries. Then the area of the total affected barangays was calculated. Also, the area of the flood extent for the 50-year and 100-year without and with levee was also computed. The floodplain covered seventeen (17) barangays with a total area of approximately 2,026.76 hectares. The 50-year flood extent without and with levee covered a total of 673.59 hectares and 682.04 hectares, respectively. The total inundation accounted for 33.23% without levee and 33.65% with levee indicating an increase of 0.42%. For the 100-year flood extent without and with levee, it covered 717.83 hectares and 719.63 hectares, respectively. The total inundation accounted for 35.42% without levee and 35.51% with levee indicating an increase of 0.09%. Based from the results, the levee was not able to reduce the inundated area of the floodplain for the two (2) scenarios. This can be attributed to the blockage by the levee of the tributaries draining into the Mandulog River. In effect, flood is still experienced inland. It is highly recommended to install a pumping system to force out the inland flood to the Mandulog River.

Keywords: Flood Structures, Flood Mitigation, Flood Control, Hydraulics, Hydrology

A TEMPERATURE, RELATIVE HUMIDITY, AND SOIL MOISTURE MONITORING SYSTEM USING GSM AND INTERNET OF THINGS PLATFORM BLYNK

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This monitoring system was developed based on the temperature, relative humidity, and soil moisture content of a plant to minimize the occurrence of excessive and irregular irrigation that leads to certain problems like shortage in soil nutritive elements and decrease in productivity. The system is composed of two nodes: the sensor node and the base node, and BLYNK mobile application program. The sensor node consists of sensors and a transmitter for the sending of data to base node. The base node is responsible for accepting data from the sensor node and it consists of a receiver and a Global System for Mobile (GSM) communication module to relay the received data to *BLYNK* cloud. The system used RF communication for sensor to base node data transmission and Global Packet Radio Service (GPRS) for base node to BLYNK cloud data transmission. The BLYNK application is used to monitor and display the data from the sensors, and sends email notification when the measured value of at least one of the sensors is below or above the set limit. All functionalities of the application program were working. The maximum operating distance for the RF module was 35 m when both receiver and transmitter modules have antenna installed. In addition, it was observed that GPRS communication was not stable, a noticeable time delay was experienced in displaying sensor data to the application. Hence, the use of more stable communication like Wi-Fi is highly recommended to avoid some communication issues.

Keywords: *Monitoring Temperature, Relative Humidity, And Soil Moisture; GSM, GPRS, RF Communications, Wi-Fi, Wireless Sensor Network*

AN INFORMATION COMMUNICATIONS TECHNOLOGY (ICT)-BASED AWARENESS FRAMEWORK FOR AIR POLLUTION LEVEL IN URBAN CITIES

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Air pollution is harmful to human health and worsens the effect of climate change. It comes from many sources such as smoke, refineries, garbage, and many more that increased in huge quantity, releasing air pollutants that results in increase of air pollution. Air pollution is a major environmental problem in both developed and developing countries and which has caused the deterioration of air quality in urban areas, thereby making the environment intolerable for human living. This study designs an ICT-based awareness framework to promote awareness in urban areas. Creating the framework required reviewing existing frameworks, related studies, other research sources, and determining the appropriate technology needed to address the problem of air pollution. As a result, the ICT-based awareness framework for air pollution level in urban cities was designed a method that can be used by governments and environmental organizations to combat the adverse effects of air pollution in urban areas.

Keywords: *Air Pollution, ICT Awareness Framework, Urban Cities, Climate Change*

ASSESSING LAND USE AND LAND COVER CHANGES IN KAPATAGAN, LANAO DEL NORTE, PHILIPPINES

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Land use and land cover (LULC) pattern provides a crucial understanding in the ecological changing processes and reflects the ecological succession and anthropogenic disturbance. The detection of LULC changes is a significant tool to assess global change and to better understand and provide solutions for social, economic, and environmental problems. In this study, LULC changes in Kapatagan, Lanao del Norte, Philippines, from 1992 to 2018, were investigated using Landsat Images. The maximum likelihood supervised classification technique was used to classify the LULC types of the acquired images, and post-classification change detection algorithm was applied to detect and monitor the LULC changes. The analysis revealed that significant change occurred in the study area as indicated by the increase of barren (17.84%), aquaculture (5.29%), and built-up (2.86%) areas, and the decrease of grassland (18.53%), forest (4.49%), cropland (2.50%), and waterbodies (0.48%). Approximately 56% of grassland and 32% of forest was changed to barren land and 8% of the waterbodies was converted to aquaculture area. This evident change has degraded the landscape and ecosystem sustainability of the area. The study evaluated the patterns of LULC for the last 26 years for Kapatagan, Lanao del Norte, Philippines that forms valuable resources for local planners and decision makers to devise land use plans and works for an integrated and sustainable land management strategies.

Keywords: *Remote Sensing, Change Detection, Land Use/Cover, Maximum Likelihood Classifier, Post-Classification Comparison*

COMPARATIVE ANALYSIS OF VERMICOMPOSTING MACHINE WITH CONVENTIONAL VERMICOMPOST PRODUCTION

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Current vermicompost production systems are based on beds and windrows in the ground. This generally requires more time in production and labor during harvesting. A vermicomposting machine was designed, fabricated and evaluated with the aim of reducing time and labor requirement during harvesting. The two production systems were simultaneously evaluated in terms of their system performance, production performance, man-power requirement and physicochemical properties of their end products. Results revealed that both production systems are qualitatively categorized having optimal condition under ROU (2002) standards on system performance. The vermicomposting machine performed better against conventional vermicomposting in terms of production performance on earthworm biomass, conversion rate and processing capacity. Labor requirement during vermicomposting was 98 man-hours for the conventional vermicomposting and was reduced into 74.5 man-hour while using the vermicomposting machine. This attributed to the reduction of time and manpower during harvesting. The vermicast produced from two production systems met the minimum requirements set by Philippine National Standard on Organic Fertilizer. Total N, P, and K of the end product products ranged from 2.5 to 5 % categorizing vermicast as a compost and with a stable pH, OM, MC and C:N ratio. Simple cost analysis showed that the annual cost charge of operating the vermireactor device is about PhP 11, 404.26 and a unit cost rate of PhP 1.42/kg of vermicompost. Break-even weight was 3,703 kg of harvested vermicompost against manual unloading on conventional vermicompost with a rate of PhP 2.35/kg.

Keywords: *Vermicomposting Machine, Vermicompost Production, Vermicast*

COMPARATIVE HYDROLOGICAL AND FLOODING ANALYSIS OF TWO LANDSCAPE SYSTEMS IN NAAWAN RIVER BASIN

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As urban area continues to expand due to an increasing trend in human population, there is an urgent need to study and identify the impacts of flooding to the community in relation with the changing urban landscapes. Two landscape systems have been separately set up in this study using the same river basin area to identify the dynamics of runoff in a given river basin. The same parameters (slope, elevation etc.) were extracted for the models except for land use parameter. The land use extracted for basin model 1 has no built-ups and roads, while basin model 2 uses building footprints and roads extracted from LiDAR data. The land use classification is associated with different Curve Number values derived from the soil type and land use itself, which was considered as the main factor that affects the behavior of surface runoff simulated in HEC-HMS. Peak time of the hydrographs, volume generated, and peak outflow were thoroughly compared. Evidently, given the two models, it was expected that the model which has built-ups classification and roads would result into faster stream flow velocities, greater peak flows and volume. Conversely, the model which has no built-up classification would most likely result in lower peak discharges and volume. This could be helpful in the crafting of appropriate mitigating measures to reduce flooding such as efficient drainage master plan, sustainable relocation sites for the vulnerable population, and by improving urban landscapes.

Keywords: *LIDAR, Hydrological and Flooding Analysis, HEC-HMS, River Basin*

CONTROLLED PERMEABILITY OF RED FIRING CLAY CERAMICS TEMPERED WITH IRON OXIDE MATERIALS

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Controlled microporous materials have been fabricated, composed of sintered Red clay and non-plastic components tempered with iron oxide materials through slip casting technique. The iron oxide generally controls the pore size of the red clay-based ceramics and acts as antibacterial agent for various applications such as fluid filtration, and for water drip irrigation with controlled distribution. Ceramic slurries were prepared which consisted of red clay, silica, mine waste and iron oxide. Three groups of different compositions were formulated to compare the permeability of the red firing clay based ceramics. The first formulations were made from red clay, silica and iron oxide only. The 2nd and 3rd compositions utilized the use of mining waste from CARAGA region tempered with iron oxide to control the porosity and further enhance the strength of the fired ceramics. Samples were formed through slip casting using plaster of paris mold and fired at 1100°C. Rheological characterization of red clay ceramic slurries loaded with iron oxide showed shear thinning behavior. Physical properties of formed ceramics show increasing apparent porosity as increasing amount of loaded iron oxide. Increasing apparent porosity decreases the vacuum pressure and increases the fluid flow rate which demonstrates a good red firing clay based ceramics for fluid filter applications.

Keywords: *Red Firing Clay, Slip Casting, Iron Oxide, Flow Rate, Permeability*

DEVELOPMENT OF INSTRUCTIONAL KIT IN ECOSYSTEM USING INFOGRAPHICS

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The main objective of the study was to develop infographics and determine its effects in the learning on Ecosystem: Flow of Energy and Matter. The study used the Quasi-experimental design with two groups (experimental group and control group) pretest and posttest design. The infographics were developed through pre-assessment, topic identification, objectives formulation, infographics designing, infographics evaluation, final revision, and publication in PDF and JPEG formats. The developed infographics were rated Excellent by the panel of experts with the use of rubrics. Findings showed that there is no significant difference between the two groups in the pretest. However, there is a significant difference between the two groups in the posttest. As rated by the majority of the respondents, the developed infographics were effective tools, and were recommended useful as a learning tool. The developed infographics were effective in the learning process of the students on Ecosystem: Flow of Energy and Matter. Lastly, the developed instrument can also be utilized even in the absence of technology due to its flexibility. It can be saved as a softcopy or be printed for further utilization especially for schools lacking with advanced learning facilities.

Keywords: *Biology, Control and Experimental Learning, Infographics, Performances, Perception*

DEVELOPMENT OF SMART URBAN GARDENING SYSTEM FOR SUSTAINABLE CONSUMPTION AND PRODUCTION: AN INTERNET OF THING APPLICATION

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Despite the advances of modern agriculture from hi-tech farm mechanization, to modern irrigation systems and advanced controlled environment agriculture, food production remains at the mercy of nature and subject to destructive elements due to climate change. Studies show that the Philippines is facing food security crisis amidst issues on increasing population in highly urbanized but poor areas. City dwellers, highly at risk for food insufficiency due to unaffordability and unavailability, are prompted to secure their own food through engaging in urban gardening; however, they perceived gardening as impossible and their last option. Skeptics on food security issues raised these questions: (1) What interventions, parameters and factors can equalize or even totally overturn the destructive impact of changing climate? (2) Is food production possible without aggravating the environment? and (3) Will there be enough food for the ever-increasing population from an ever-declining arable land and ever-worsening climate? The Food Agriculture Organization (FAO) shows optimism of an abundant world food supply through the availability of today's technical knowledge: By utilizing advanced systems to grow more food while conserving earth's limited resources. With this, the researchers were motivated to conduct a "Development of a Smart Urban Gardening System for Sustainable Consumption and Production: An Internet of Thing application (SUGS-SCP: IOT)", which aims to help prospective users to monitor and take care and their gardens despite their absence. Findings will show that the use of the system will increase the production of food regardless of various problems on gardening and will help solve food crisis.

Keywords: *Urbanization, Food Security, Smart Urban Gardening System for Sustainable Consumption and Production: An Internet of Thing (IoT) application, Microcontroller*

DYNAMIC AUTOMATED PCDUINO-BASED POWER MANAGEMENT SYSTEM

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The increasing annual population of employees and students in an academic institution contributes to unsustainable practices of electricity use and increasing electric bills. Research shows improper energy use such as of air-conditioning (AC) units correlates to significant increase of planet-warming emissions that greatly contribute to global warming and climate change. Using the IPAT equation as basis for calculating the multiplicative contribution of factors - *Population*, *Affluence*, and *Technology*- that cause Environmental *Impact*, this study attempts to reduce energy consumption using a system called, Dynamic Automated PcDuino-Based Power Management System (DAP-PMS). The system controls both energy usage and classroom utilization usage outside of programmed class schedule by applying automation (PIR Motion Sensor), effective illumination, and lighting standards & control techniques. The system components are all calibrated and tested based on functionality and efficiency. After several tests and pilot implementation in the research locale, Mindanao State University – Iligan Institute of Technology (MSU-IIT), results revealed that the system is useful in reducing energy consumption, through automating classroom time scheduling and automating light switch, computer units, and AC units based on human movement detection. Findings further revealed that there is a significant difference in the energy consumption which yielded minimum of 16.11% savings on lightings and 5.67% on AC and computer units. In conclusion, energy reduction helps the environment by decreasing power plant emissions that will reduce impact to global warming. The DAP-PM System can be potentially applied in all infrastructures in institutions and government offices to maximize energy reduction.

Keywords: *Dynamic Power Management System, Energy Reduction, PcDuino, IPAT equation, Control Lighting System, Global Warming Reduction.*

FLOODPLAIN ENCROACHMENT: A CASE STUDY ON THE LARAPAN RIVER FLOODPLAIN

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The study attempts to provide a methodology for a rapid assessment of flood dynamics over an area using HEC-RAS 5.0.5. HEC-RAS has been improved and includes new abilities of performing 2D flood routing over a large area at variable time steps. Its computational engine also has been parallelized in a 64-bit environment resulting to reduced run times even for large watershed areas. The study was performed on a 210-km² watershed with LiDAR-derived DEM covering almost 70% of the area including its floodplain. The LiDAR DEM was resampled to 5-m resolution and fused with a 5-m resolution IFSAR DEM for the remaining area of the watershed. The whole watershed was considered as 2D flow area at 30m x 30 m flow grid with a break line on the highway centerline. HEC-HMS is used to estimate excess precipitation over the area. Several simulations are performed at established rainfall probabilities of 4%, 2% and 1%. Results are compared from flood simulations performed on terrains before and after the presence of major built infrastructures on the floodplain. Results show that full 2D unsteady flood modeling over a whole watershed could be used to provide a rapid assessment on the flood dynamics over an area. Major effects include changes in flood extent especially at deeper flood depths, increase in flood depths and temporal changes with respect to arrival time and duration of flood. The methodology used in this study could be used to properly evaluate proposed infrastructures that need to be built on our floodplains.

Keywords: *Watershed Modeling, Flood Mapping, 2D Hydraulic Modeling, HEC-RAS 5.0.5*

FLY ASH-STABILIZED INTERLOCKING COMPRESSED EARTH BLOCKS (ICEB) FOR NON-LOAD BEARING WALL APPLICATION

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Interlocking Compressed Earth Blocks (ICEB) – a building material made from soil, sand, and cement compressed using a Cinva Ram press. The blocks are strong, durable, and with good thermal and sound insulating properties. Its production cost, however, remains higher than the traditional concrete hollow blocks (CHB) due to Portland cement, making it less popular to the local construction industry. On the other hand, the availability of fly ash – a pozzolanic byproduct of coal-fired power plant – presents an opportunity to reduce ICEB's unit cost and the associated environmental impacts by replacing cement with fly ash. This paper presents the effect of fly ash replacement to the compressive and flexural strength of ICEB, by varying the amount of fly ash to cement ratio. The compressive strength test result revealed that all mixtures containing fly ash at 28-day curing period is relatively lower than the control mix. ICEB with 40% fly ash replacement, however, showed compressive strength comparable with the control group, enough to support a wall of ICEB at a height of 3.0m. The low strength development of ICEBs with fly ash is due to the delayed pozzolanic reaction, which requires longer time to initiate in the case of fly ash. The flexural strength test, on the other hand, also showed that ICEBs with 40% fly ash replacements (13.79kN) is higher than the control mix (13.71kN), at 28-day curing time. These results imply that fly ash is a viable binder for ICEB to be used for non-load bearing wall and similar applications.

Keywords: *Interlocking compressed earth blocks, Fly ash, Non-load bearing wall, Supplementary cementitious material*

GIS BASED NATURAL DISASTER RISK ASSESSMENT FOR SPATIAL PLANNING

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Most of the community development plans compulsory to the local government units (LGUs) require climate-adjusted scenarios and must adapt to the guidelines set by the approving agency. In order to develop a more sustainable plan, the LGU must identify first the high-risk areas as well as the safe areas where developments may take place. Natural disasters are the most common in many coastal municipalities, especially in Kapatagan, Lanao del Norte. Risk assessment is vital in identifying high-risk areas in a community because it will aid them in the development of their local plans and in crafting their local policies and ordinances. Datasets were gathered to develop vulnerability maps, adaptive capacity maps, and multi-hazard map composed of flood, neo-tectonic, and landslide maps. The resulting maps were overlaid to each other and were processed using Geographic Information System (GIS) to facilitate identification of high-risk barangays. The identified high risk barangays are mostly coastal barangays and interior barangays like Barangay Balili, Conception, Sta. Cruz, Waterfalls, Bel-Is, Cathedral, Margos, and Lapinig. All maps generated will be integrated into their local plans to aid the municipal officials in planning, managing, deciding, and executing plans for sustainable development.

Keywords: *Adaptive capacity, GIS, hazard, Risk Analysis, Vulnerability*

ICT4SFM-CA: MODEL FOR CLIMATE ACTION USING INTEGRATIVE VISUAL NEURAL NETWORK SIMULATION

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Over the last several decades, humanity has been facing great challenges on the use of ecological resources such as sustaining these resources for the current and future generations. But climate change (CC) will continue to impact almost all- the land, the forest, crop production, among other things on earth. This study focuses on the development of a new framework integrating the information and communication technology, sustainable forest management and climate change mitigation and adaptation based from the goals, target, and indicators (GTIs) of the 17 sustainable development goals 2030. The framework uses visual neural network analysis and simulation to determine the degree of influence of each indicator leading towards Climate Action (CA) and integrating ICT and sustainable forest management (SFM). Studies reveal little evidence that draws degree of connectivity of various indicators, targets, and goals of the convergence of ICT, SFM, and CA. The methodology involves the iterative ADDIE Model: Analyze, Design, Develop, Implement & Evaluate using the Visual Neural Network Simulation (VNNS) to indicate the direct, indirect and extended relationship among variables- SFM, SDG, ICT and CA. Result of the study visually indicates the degree of centrality of Goal #13 (CA) towards other Goals: Goal #15 (Life on Land), Goal #9 (Industry, Innovation and Infrastructure) and 5Ps (People, Planet, Prosperity, Peace and Partnership) and Geospatial indicators. In conclusion, the model showed the outer layers - ICT, SFM and SDG 2030 with highest direct influence to Climate Action, being the center of influence.

Keywords: *Sustainable Development Goals, Information and Communications Technology, Climate Change, Sustainable Forest Management, Visual Neural Network*

INDIVIDUAL-TREE DIAMETER INCREMENT MODELS BASED ON ARTIFICIAL NEURAL NETWORKS FOR MIXED STANDS OF *Pinus brutia* AND *Pinus nigra* IN WESTERN TURKEY

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Growth and yield information is important for sustainable forest management when deciding effective planning strategies, and current and future stand conditions become the main components of decision process. While the current data are obtained from forest inventory, growth and yield models are needed to predict future state of a stand. Individual-tree diameter increment models are one of the most essential and basic components of forest growth models, since diameter increment estimates are the main inputs in growth and yield modeling. Regression analysis is the most common approach for modeling diameter increment as well as other growth patterns. The data for these studies are collected from multiple observations over time on the same trees, so the observations used for increment modeling have autocorrelation problem and violate the regression assumption of independent and homoscedastic data. However, artificial intelligence techniques have considerable flexibility to overcome autocorrelation problem in modeling process and to provide successful estimates with developed models. In this study, individual-tree diameter increment models based on artificial neural networks were developed for Turkish pine (*Pinus brutia* Ten.) and black pine (*Pinus nigra* J.F.Arnold) growing in mixed stands in western Turkey. Within the models, 10-year diameter increment of individual trees was dependent (output) variable, while some tree-level characteristics (i.e., diameter at breast height, age and competition index of subject trees) and stand-level ones (such as stand density, site class, mean diameter and mixture ratio of the stand which the subject tree located) were candidate independent (input) variables. As a result, the models developed were successful in estimation of diameter increment for both tree species.

Keywords: *Artificial Intelligence, Machine Learning, Growth, Pine, Stand Characteristics*

MICROCONTROLLER-BASED POTABLE WATER MONITORING SYSTEM WITH SMS NOTIFICATION

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Water Scarcity is a problem which is often underrated by the world today. The insufficiency of water available for drinking due to water pollution and contamination has been affecting billions of people in the world. In addition, it aggravates recurring global problems on water supply. While the problem is getting bigger, people failed to utilize different water sources in the community due to lack of facilities to treat water. Through the years, science and technology has been instrumental to the development of appropriate innovations and solutions to this growing problem on unsafe water. The researchers targeted a rural community where there is abundant supply of water but reportedly experiencing problems on contamination and pollution. Likewise, the need to monitor water quality is a significant step in protecting water sources in different areas. The researchers then developed and designed a system known as Microcontroller Based-Potable Water Monitoring System with SMS Notification (MB-PWMS), to monitor potable water properties specifically spring water, through Filtration process. Components of the system include Arduino MEGA 2560 R3, Ultrasonic sensors, pH and Turbidity sensors, Flow sensors, Sim800L mini GPRS Breakout Module, Real Time Clock Module, Carbon Filter and UV Lamp. Based on evaluation, the system is found to be functional and effective. If deployed, the MB-PWMS could have a great impact to the community people in their needs of safe water. The study recommends the use of solar panel and battery as back-up power use for the system.

Keywords: *Microcontroller, Water Monitoring, Filtration, Water Security, Potable Water, Water Scarcity*

MODELLING RUNOFF USING DIFFERENT ARTIFICIAL NEURAL NETWORK METHODS AND MULTIPLE LINEAR REGRESSION

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The runoff is a significant feature in stream water mechanism as it affects directly management of water resources. In this study, daily runoff was obtained in a forested watershed was modelled using different artificial neural network (ANN) methods and multiple linear regression (MLR). A stream water of watershed was monitored from 1967 and January 2003. Feed forward back propagation (FFBP), radial basis function (RBF) and generalized regression neural network (GRNN) have been used as ANN algorithms. The prediction of each models was compared between estimated (computed) and measured outputs. The comparison criteria of the methods were used correlation of coefficient (R²), mean absolute error (MAE), root mean square error (RMSE) and relative error (RE). The results indicate that the node number of input layer and its data combination determine to obtain the more accurate of ANN model outputs. The cross-correlation and autocorrelation of input data provide a useful tool about to find input layer node number of ANN algorithms. The FFBP performance was found to be superior to other ANN algorithms and classical statistical method (MLR).

Keywords: *Suspended sediment loads, Runoff, ANN, FFBP*

PRODUCTION AND EVALUATION OF RED CLAY-BASED SLIP CASTED WATER FILTER

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Drinking water source is depleting to a degree that threatens the health of the people especially the vulnerable sector of the society, the infants and children. To mitigate the problem, low- cost red clay-based ceramic water filter would be an alternative solution to eliminate the contaminants present in drinking water. Ceramic water filter was fabricated through slip casting technique by mixing indigenous raw materials of red firing clay and silica sand in various proportions; 40:60, 50:50 and 60:40 ratios respectively; deflocculated using 0.3-0.8% sodium silicate; containing 60-70% solid loading and a specific gravity ranging from 1.70-1.80. The aged slip was casted in a Plaster of Paris mold, drained after the desired thickness was achieved; air dried for two days; oven dried at 110⁰C for 4 hours and fired at temperatures of 900⁰C, 1000⁰C and 1100⁰C in an electric kiln. Flowrate of the fired filter, the breaking strength and water absorption, shrinkage, porosity and the effectiveness of water filtered to conform to the standards of the potable drinking water were evaluated. Varying the amount of silica and increasing the firing temperature resulted to an increase of apparent porosity from 35-40%; the flowrate from 300-2,000ml/h; the water absorption from 24-28%; and reduce the total shrinkage from 10-5%. Moreover, as the amount of clay increases the casting thickness of the filter increases from 5.5-6.5mm/30m as well as the apparent viscosity. The permeability increases with the silica content and with the firing temperature specifically at 1100⁰C resulting into a 1500 to 2000mL/h enough to supply seven family members a day. Scanning Electron Microscope (SEM) images of samples have shown that the filters have dense inter-granular porosities of about 0.20-0.60µm. Microbial efficiencies of the ceramic water filters have been tested and effectively eliminate the Coliform and *E. coli* bacteria as well as satisfied the requirements for standard drinkable water.

Keywords: *Ceramic Water Filter, Slip Casting, Porosity, Water Absorption, Flow Rate E. coli*

RELATIVE ACCURACY OF FLOOD MODELING USING LIDAR DATA AND COARSER RESOLUTION ELEVATION DATASETS

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The representation of topography plays an important role in determining the accuracy of flood inundation maps. One would expect high accuracy of flood modeling results if one uses a more detailed elevation datasets such as LiDAR-derived 1-m resolution elevation datasets. Although LiDAR data is accurate, it is not available in several areas across the country. It would be helpful to know the relative accuracy that one is able to accomplish when flood modeling is done using coarser resolution elevation datasets. The study proposes to quantify the errors arising from DEM properties such as resolution and accuracy on flood inundation maps. Detailed comparison of flood hazard maps generated using LiDAR datasets to that when using a coarser 5-m resolution elevation data. It is expected that a map produced using LiDAR data is more accurate but knowing their difference would give us some idea of accuracy when coarser datasets is the only data available for a given area of interest. Initial work would start with comparison of datasets, for example, maximum land surface elevation difference, the mean elevation difference and range of values based on randomly selected sample points over the area. Flood inundation comparison is done using LiDAR-derived elevation datasets and a 5-m resolution over a single study area. Flood inundation comparison will be completed using HEC-RAS which can generate flood depth grids. Quantitative comparison of the water surface profiles and depth grids will indicate difference of flooding extent, volume, and maximum flood height.

Keywords: *Flood Modeling, LiDAR Data, Flood Inundation*

RUN-OFF SIMULATION IN BARANGAY POBLACION, KAPATAGAN, LANAO DEL NORTE USING HEC-RAS 5

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Local authorities report that the municipality of Kapatagan has been vulnerable to flooding when experiencing moderate to heavy rainfall. Anthropogenic activities in the surrounding area have made the municipality more vulnerable to flooding. The necessity to build flood control infrastructure has been growing. However, there is a lack of scientific data to support the infrastructure plan of the local government. This study produced a computer-generated model using Hydrologic Engineering Center River Analysis System (HEC-RAS) 5 to calculate the run-off in Barangay Poblacion, Kapatagan Lanao del Norte. A 25-year return period, 50-year return period, and 100-year return period Rainfall and outflow data were used to establish the model. Results showed that the 25-year return period has the least area of effect compared to the other two with an effective area of 197.5 hectares or 43.8% of the area of barangay Poblacion. The 50-year and 100-year return period has an area of effect of 346.42 hectares or 76.9% and 352.98 hectares or 78.4% respectively

Keywords: *Run-off, HEC-RAS, Kapatagan, Flood Control, Rainfall*

SMS-BASED MONITORING OF UNDERGROUND TRASH BIN FOR EFFICIENT SOLID WASTE MANAGEMENT

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Rapid population growth and developments have greatly contributed to the increasing waste production in urban areas. Research shows improper solid waste management has negative impacts to both human health and the environment. This study looks into the collection and monitoring of solid waste disposal among residents in Iligan City by using underground trash bin system with geo-mapping and real-time GUI locator. The system is built with a push button locking system to be accessed by the garbage collector, Infrared (IR) sensor that detects minimum clearance when the bin is full, and a LED indicator and gas sensor to detect a hazardous odor inside the trash bin. A short message service (SMS) via GSM was employed to send the trash bin location to the main office and onwards to the garbage collectors. Result indicate a fully efficient and functional SMS notification on geo-mapping system based on its features, functions and operations. As an impact, the system can be helpful in minimizing the spread of diseases caused by uncollected garbage and lessens the environmental pollution. This study recommends a full implementation of the system to other urban areas.

Keywords: *Underground Trash Bin, Garbage Collection, Solid-Waste Management, Short Message Service (SMS), Notification System*

SUITABILITY MAPPING OF KEY CROP COMMODITIES IN MISAMIS OCCIDENTAL

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The agricultural crops of Misamis Occidental are not exempted from the effects of climate change hence, it is necessary to assess and map out the key crop commodities in terms of their suitability in the near future. Five major crops were identified namely; lowland rice, coconut, banana, cassava, yellow and white corn from Philippines Statistics Authority (PSA) and Department of Agriculture (DA) (2016) and validated by the community stakeholders. Crop vulnerability and suitability mapping were based on flood and landslide hazards prevalent in the area together with baseline (agro-climatic) data. The data were analyzed using Multi-criteria Decision Analysis based on Analytical Hierarchy Process for ArcGIS. Future climate models were based on IPCC Representative Concentration Pathways of which trajectories are represented by 2050 RCP between medium case scenario (4.5) and worst case scenario (8.5), respectively. Most crops are not feasible in upland areas (RCP 8.5). Meanwhile, corn and banana are moderately suitable in low-lying areas provided that the temperature is higher than the total crop requirement. However, both corn and banana are relatively affected by higher rainfall (RCP 8.5). Planting of cassava, coconut, and rice in low-lying areas has a moderate to high suitability under RCP 8.5. Based on simulation model, these crops may adapt and suitable in low-lying areas but not in an upland areas inspite of climate change.

Keywords: *Crop Suitability, Representative Concentration Pathway, Species Distribution Model*