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Research Digest



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Message from Publication committee

We, publication team proudly present you the most awaited Research Digest, which briefly highlights the research work of Nepalese Engineers studying/working in Japan. In this Research Digest, you will find the state of the art research performed by Nepalese Engineers.

We hope you will enjoy going through the research area of your NEA-JC colleagues.

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Research Keywords: Debris flows, sediment disasters, floods, landslides, glacial
lake outburst floods, driftwood disasters, numerical simulation

Current Research

Preparation of National Road Map for Flood Early Warning System in Bangladesh

Brief description of current research work Bangladesh is one of the most flood prone countries in the world. The potential area for river flooding accounts over 80% of total country area, out of which about 75% lies below 10m elevation. Flooding normally occurs during the monsoon season from June to September and dominated with the hydrology in cross-border areas. There are 310 rivers in total, including 3 major rivers (Ganges, Meghna and Jamuna). Only 7% of the total basin areas of these rivers lies in the country but cause often flood in major part of Bangladesh.

Since the flood damage has been a big setback to national economy of Bangladesh, therefore to the national development, the flood forecasting and early warning system has become an essential element in the development process. The importance of Flood Early Warning System (FEWS) is highlighted not only in the context of changing socio-economic conditions of Bangladesh but also in climate change, which has already had serious impact in Bangladesh. Majority of flood vulnerable population those live in rural areas and majority of urban population are being greatly exposed to flood disaster with little or no access to reliable flood information. The reliability of such information concerns not only the timing and accuracy of flood forecast information but also the process of early warning information development and dissemination as well as the clarity in disseminated information. There is a lack of efficient FEWS and also a huge overlap and duplication of stakeholders in FEWS project planning and implementation. Thus, we are developing a National Road Map for FEWS in Bangladesh. Such a roadmap is expected to be useful to guide the preparation of long term national plan and can be used by the government agencies and donor agencies for screening and ranking of investments on FEWS development projects.



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Current Research

Memory Optimization and High Speed Computation of Moving Particle Semi-Implicit method in CUDA Technology

The research includes two sections Memory Optimization and High Speed Computation. GPU memory is very limited so we implement various memory optimization methods for making GPU for very large number of particle data more than 1 million to billions of particle. Next is high speed computation where we use cuda technology and speed optimization technology to calculate such a large number of particles within 8 hours.



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Research Keywords: Climate change, GCM downscaling, Hydrologic modeling,
Water resources management

Current Research

Bias correction of daily GCM precipitation for climate change impact assessment

Climate change scenario projections, which are simulated by Global Climate Models (GCM), are extensively used for assessing climate change impact on different sectors. Because of oversimplification of global climate system in the GCM, projected values consist of significant biases. Therefore, these projections may not be suitable for direct use at local (basin) level impact studies. My current research aims to correct biases in daily GCM precipitation at grid cell scale over upper Bagmati river basin using quantile-quantile bias correction technique. In this technique, GCM grid data is linked to observation stations data that are located inside or nearby the grid cell. Delineation of homogeneous regions has been proposed for linking neighboring observation stations to a grid cell. I have employed 20 km daily GCM precipitation of Meteorological Research Institute, Japan. Calibration and validation of regionalized bias correction technique was performed for periods of 1979-1993 and 1994-2003 respectively. The regionalized bias correction technique was found to be noticeably improving any biases in the GCM precipitation. Using bias-corrected data, climate change impact assessment was made for 1979-2003 and 2075-2099 periods as current and future climate respectively. Climate change impact assessment was carried out in term of annual, monthly and daily precipitation values. The analyses revealed that annual precipitation will increase significantly in the future. The study also found that there will be significant increase in monsoon precipitation and decrease in other months. Concerning climate change impact on extreme (maximum) precipitation events, the study found that there will be more extreme precipitation.



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Current Research

Coating of solvent impregnated resins with a semi-permeable membrane for durable performance during metal recovery

Electroless nickel plating is a very popular finishing technique for plating advanced materials used in the field of electronics, pharmaceuticals and aerospace engineering. High quality, applicability to non-metals and uniform coating on geometrically awkward parts are some of the special features of this technique. My research work is related to the plating of aluminum alloy substrate in which zinc is plated on it prior to the plating of nickel, for better effects. The zinc, being substituted by nickel, accumulates in the bath and obstructs both productivity and quality.

The objective of my current research is to remove the zinc selectively without affecting the nickel bath by employing solvent impregnated resins (resins holding zinc extractants in their porous structures). However, the extractants often leak out of the resins and are not suitable for cyclic operations. For making the resin durable by controlling the loss of the extractant, a thin semipermeable membrane of cross-linked polyvinyl alcohol is coated on its surface. Since a highly cross-linked membrane may hinder permeability for zinc also, thus making zinc extraction less effective, a balance is to be maintained between the desired level of leakage control and desired extent of zinc extraction. Thus, optimization of the membrane parameters is my goal and it has been achieved to some degrees till now.



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Current Research

Concept of residual-state creep test to understand the creeping behavior of landslide soils

Landslides are one of the major natural disasters in mountainous regions. They have claimed thousand of human lives and extended an economic loss of billions of dollars in individual property and national infrastructure damages in the recent years. There are several evidences that the sources of these landslide disasters are the sparsely distributed large-scale landslides, which is most occasions' exhibit creeping displacement behavior. A heavy amount of national budget is spent in managing these landslides, in which the major interest remains at the minimizing the creeping displacement of these landslides and thereby reducing the damage risk to the human settlement and structures over the landslides mass or to the environment. However, the creeping displacement behavior of such landslides and associated geotechnical issues are not fully understood, especially in relation with the displacement behavior at residual state of shear of slip surface soil. This research has primarily addressed this issue with the help of experimental results, and has attempted to interpret the results towards the possibilities of predicting landslide displacement and long-term management.

Based on test results, the main findings of this study are as:

- 1) the residual-state creep test set up is developed in the laboratory using a modified torsional ring shear machine, which is adequately capable of evaluating the residual-state creep behavior of landslide soils,
- 2) new concept of residual-state creep test and its testing procedures are developed,
- 3) the ideal creep curve for a soil material was verified in the test procedure and was found to perfectly matching with obtained results,
- 4) when a soil material is in residual-state, the creeping displacement behavior is exhibited only under a shear stress greater than the residual strength.,
- 5) prediction curves are purposed for predicting the time until complete failure and its corresponding displacement.



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Current Research

Development of a Novel Type of Micro-tubular SOFC for Advanced Power Generation

Solid oxide fuel cells (SOFCs) are regarded as one of the most promising electrochemical devices for power generation due to their numerous favorable characteristics such as high energy conversion efficiency, ability to run on direct hydrocarbon fuels, and possibility of utilizing high-temperature waste heat in combined cycle applications. Out of two main types of SOFC designs (planar and tubular), tubular ones are preferred taking into account their technological maturity, stable performance over long runs and the ease of gas-tight sealing. However, one of the major drawbacks of tubular SOFCs is their low volumetric power density. Conventional tubular SOFCs developed for large-scale power plants typically have a diameter of 2.5 cm and a length of 1-2 m. But recently to increase the surface area to volume ratio so as to achieve higher power density, micro-tubular SOFCs having a diameter in the range of 1-5 mm have been introduced. Still, current collection from the bore side (*i.e.* inner electrode) has been proved very critical for such designs owing to the contact of current collecting elements only at the ends of the electrode. To deal with this issue, the current research proposes a novel type of micro-tubular SOFC based on ceramic hollow fibers (HFs). Computational fluid dynamics (CFD) simulations are being carried out to validate the significance of the proposed design in terms of current collection efficiency and power density of the cell. The simulations consist of the modeling of electrochemical properties coupled with physical phenomena such as heat and mass transfer. Based on the results obtained from the numerical simulations, the performance of the proposed micro-tubular SOFC will also be characterized experimentally.



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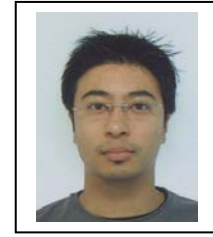
Current Research

The effect of compaction history on the mechanical behaviour of compacted clay

Compaction has a key role on the mechanical and hydraulic behaviour of compacted fine grained soils. A set of triaxial compression (TC) tests, composed of isotropic consolidation drained and undrained shearing test, are carried out on fully saturated specimen of Kaolin clay soil to investigate the effect of compaction history on mechanical behaviour. Specimens are prepared by compacting at different water contents and dry density by applying different compaction effort. The specimens are made fully saturated before consolidation and the volume change during saturation is determined. This phenomenon is known as Collapse. The specimen is confirmed as fully saturated if B-value ≥ 95 %. The compressibility characteristics were analyzed by isotropic consolidation test at stress level, $p' = 650$ kPa. The specimen is initially at over consolidated state during preparation. However, it is changed to normally consolidated state by applying high effective pressure during isotropic consolidation before shearing test. The undrained shearing test is performed after consolidation at specified strain rate upto axial strain 16%.



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Current Research

Influence of moisture in the shear bond properties at FRP concrete interface

The externally bonded FRP reinforced structures are the one of the most popular methods of strengthening the RC structures. The key issue in this method has always been the interface between concrete and FRP as it is the weakest link in the whole composite system. The premature failure of the interface is hindering the effective utilization of the FRP materials. Many past studies are mainly focused on the bond properties of FRP concrete interface but only limited studies have been found with consideration of environmental effects on the interface properties and its constituents. The structure experiences different kinds of severe environmental exposure such as moisture, freeze and thaw, extreme temperature throughout the service life but among that moisture is considered as one of the very important degradation cause for the early deterioration of bond between FRP and concrete.

The most prominent effect of moisture could be seen in the resin matrix. The resin matrix absorbs water and the amount of water absorption mainly depends on the type of resin and the water temperature. Epoxy resins are commonly used as resin matrices due to its higher resistance against corrosion, water and heat compared to other polymers. Despite these characteristics detrimental effects of moisture have been reported. Lowering of glass transition temperature due to plasticization, significant reduction in mechanical properties are few of the directly observed effects due to water ingress into the resins. However understanding the effect of moisture in the long term durability in the bond properties between FRP and concrete interface is very limited. Therefore experimental studies on the effect of moisture on the material and the bond properties are currently ongoing.



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Research Keywords: Beam-column joint, rigid-framed bridge, seismic loading, steel fiber



Current Research

Contribution of Steel Fibers in Reducing Steel Rebars in Beam-Column Joints of Rigid-Framed Bridges

After many columns and beam-column joints of rigid-framed railway bridges suffered heavy damages due to shear failure including complete collapse of many RC viaducts during 1995 Kobe earthquake, the bridge design standards were drastically improved. In the rigid-framed bridges designed based on the new railway design standard, large amount of steel rebars with elaborated rebar detailings became mandatory. The demand of large number of steel rebars along with the provision of hooks at the ends of rebars imparts the over congestion at the beam-column joints.

The current study was conducted to reduce not only shear rebars but also longitudinal rebars in a beam and a column of rigid-framed bridges to avert the over congestion at the beam-column joints by using steel fibers. The experimental results of T-joints and knee-joints of the rigid-framed bridges revealed that the steel fibers are capable of restoring the strength deficit and energy dissipation caused by the reduction of longitudinal and shear rebars in beam-column joints. The use of steel fibers altered the failure mode of the joints from anchorage failure to the flexural failure which is the desirable failure mode particularly for the seismic resistant structures. The improved performance of the steel fiber reinforced concrete specimens with reduced steel rebars compared to that of the conventional specimens proved the applicability of steel fibers to reduce the congestion at the joints through the replacement of certain amount of longitudinal and shear rebars by 1.5% of steel fibers.



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Research Keywords: Slaking, landslides, creep deformation etc.



Current Research

Cyclic Wetting and Drying Induced Creep Deformation of Crushed Mudstone in Direct Shear Test

Mudstones experience periodic swell and shrink behavior due to alternate wetting and drying cycles with distinctive seasonal changes. It also tends to slake and soften when in contact with water and has given rise to numerous stability problems around the world. In addition, when high embankment made of these materials is considered, long term stability and settlement problems may possibly arise from the occurrence of slaking of geo-materials due to repeated wetting and drying cycles. The wetting and drying cycles cause particle size reduces and shape changes with significant reduction in shear strength and increase in deformation. A large creep deformation and reduction in the peak shear strength of crushed mudstone after immersion was reported by many authors. Similarly, several methods have been developed to assess the influence of cyclic wetting and drying of geo-material under unconfined conditions. However, cyclic wetting and drying in the field typically occurs in the presents of normal and shear stresses.

In my study, a series of direct shear tests are performed with advanced direct shear apparatus under different stress ratio, R . Specimens are consolidated at prescribed stress ratio, R , then they are wetted and dried alternatively under constant shear loading and finally monotonic shear load is applied after third wetting to observe shear strength and deformations characteristics. Distilled water is supplied from the bottom of shear box for wetting, while for drying, first water is drained out, then, dry air is pumped from the bottom of the shear box and the shear box is covered by silica gel to absorb moisture from specimen while room temperature was maintained at 30° C. A moisture sensor was inserted into shear box to measure the water content of the specimen instantaneously. Sieve analysis is also performed to investigate the changes in particles size distribution and degradation index.



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alloys, Seismic retrofitting/reinforcing, Masonry structures,
Reinforced Concrete Structures, Steel Structures



Current Research

Application of superelastic alloy bars in seismic applications

Superelastic alloy (SEA) bars, more commonly called as shape memory alloy (SMA) bars, with their capability to recover deformations have strong potential to be used in various seismic applications. This study involves experimental and numerical investigation to check the applicability of newly developed Cu-based SEA bars as seismic control devices. Few preliminary works done on masonry, concrete and steel brace frame systems stated effectiveness of Cu-Al-Mn SEA bars, characterized by large recovery strain, low material cost, and high machinability, as partial replacements for steel bars.



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Research Keywords: Continuum Mechanics, Non-linear Elasticity, Wave Propagation



Current Research

Wave Propagation in Pre-stressed Elastic Media

The context of the study is the non linear elasticity theory, also called finite elasticity. This theory accounts for the behavior of elastic materials which can suffer large deformations. The theory of elastic materials subjected to large deformations was initiated in the early 1940's, primarily motivated by the need of an adequate description of the behavior of natural rubber. It has considerably advanced since then. Significant theoretical results, many confirmed by experiments, have provided substantial insight into the physical behavior of rubberlike materials such as synthetic elastomers and polymers, in addition to natural rubber.

This study investigates the propagation of infinitesimal amplitude and finite-amplitude plane waves in elastic composites which are maintained in a state of arbitrary static finite homogeneous deformation. Although the materials are assumed to be isotropic, the static deformation let them behave as anisotropic for wave propagation. This effect is called strain-induced anisotropy. Several new exact results have been obtained so far.



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Research Keywords: Wastewater, advanced oxidation techniques, pharmaceutical compounds, perfluorinated organic compounds



Current Research

Vacuum ultraviolet radiation for oxidation of perfluorinated organic compounds

My present research activities include assessing feasibility of UV-based advanced oxidation techniques in eliminating emerging organic micropollutants like pharmaceutical compounds and perfluorinated organic compounds in wastewater streams. The particular focus of the research is on perfluorinated compounds (PFCs) like perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) and use of vacuum UV (VUV). The ultimate goal is to develop a more efficient oxidation method for complete mineralization of the PFCs in wastewater streams.



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Current Research

**Optimum water resource management incorporating the climate change phenomena
(Proposed)**



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Research Keywords: Road network reliability and vulnerability

Current Research

Evaluation of road network from the reliability and vulnerability perspective

For the economic development of a nation and to provide the services and facilities to the citizen, reliable transportation network is a must. Transportation network suffered from the natural disaster and human activities cause partial or complete disruption in the transportation system. During emergency situation, or when extreme disaster happens three kinds of problem will be observed. The first one is connectivity failed between two locations; there is no other option/route/link to connect between the two locations, hence some area becomes isolated. Second one is travel time is increased due to detour route. Third one is traffic flow increase in the other survived route immediately after the disaster and problem of capacity/congestion in the survived route. A severe impact on the community can arise such as problem on rescue and evacuation, problem on post disaster logistic supply and high impact on economy.

Road network planners need a very simple and practical decision making tools to decide where they should concentrate their resources to make robust network. However the severity and weakness in the network are differing from location to location. Identification of weakest point and critical links in a network and prioritize them for the improvement projects is the aim of the evaluation methodology. Numerous studies have been done to develop the methodology of evaluation; however practical methodology is still lacking. So the current topic of my research involves the development of practical evaluation methodology, mainly focusing from the disaster vulnerability point of view.



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Research Keywords: Urban freight transportation; hazardous material; optimization



Current Research

Planning Hazardous Material Routing in Urban Areas

Decision making for routing vehicles carrying Hazardous Material (HazMat) is an activity of considerable importance both in terms of economics and safety needs. Both the cost (time) and safety (risk) modeling for HazMat distribution in urban cities are extremely challenging and requires significant analysis. A static multi-objective HazMat transportation model and a meta-heuristic solution technique based on multi-objective ant colony system was presented in the doctoral thesis. In real life situation, population in the concerned areas keeps on varying with time and with increased traffic volume and congestion level, the travel time no longer remains static. Therefore, to be realistic, the problem must be solved as a dynamic routing problem. Also, with urbanization, the consequences of the HazMat accident becomes more intense, and necessitates detail risk modeling. Addressing these issues, the ongoing research aims to develop a multi-objective optimization tool to solve a dynamic Vehicle Routing and scheduling Problem with Time Windows (VRPTW) for HazMat distribution in urban areas.



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Research Keywords: Pore pressure, Soft Computing, Parameters



Current Research

Analysis of highly fluctuated pore pressure change by using soft computing techniques

The change of pore pressure in the rock mass around the site of Mizunami underground research Laboratory (MIU) was analyzed by linear (GA) and non linear (ANN) model. Previous study shows that prediction by these models are better when input and target pattern are similar, however such selection is not always possible, hence in this research we tried to predict using different input and target pattern; mainly focusing on predicting on fluctuated pattern. Appropriate parameters selection are important in such models, hence appropriate parameters used in these models were studied, different analytical cases were analyzed on the basis of data from different geological formation, fluctuation pattern and variation in input and target time interval. The results shows that GA is well applicable in all cases whereas ANN is affected when input and target fluctuation pattern are different. Furthermore, it was observed that hourly data gives better result than daily and 5 minute data in both ANN and GA cases. GA and ANN are both black box models that means these models do not consider the physical parameters rather the main concern of these models are dealing with pattern of data, therefore these models are well applicable in variety of fields having time series data base such as temperature, air pollution, radioactivity and so on.



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Current Research

Development of hydrophobic capillary barrier system for solid waste landfill capping

Alternative earthen capping systems such as capillary barriers and evapotranspirative covers are recognized as useful technical solutions for landfill final cover systems in developing countries semi-arid and arid climate. However, their application to the landfills at wet regions seems to be matter of concern due to loss of their impending capacity under high precipitation. In developing the possible concept of “hydrophobic capillary barriers”, the development technique to enhance the impermeable properties of capillary barriers, which consists of turning the coarse grain surface of subsoil water repellent by mixing it with low-cost and locally available hydrophobic material such as oleic acid and stearic acid were discussed by water repellency tests. The desired characteristics of such techniques are: (a) allow use of soils located nearby the landfill, (b) assure the sustainable and long term performance, (c) be economically affordable to be implemented in developing countries.



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Current Research

Evaluation of Human perception and comfort of combined effect of vibration and noise for the assessment of building vibration

The development of new technology and the use of new materials in civil engineering structures during the last few years have increased the problems caused by vibration in building. Such problems are made worse when the material used for these structures is steel. The fact is related mainly to the low damping values of this material, which increases the vibration transmissibility in such structures. Vibration can cause problems from structural integrity of buildings to affecting comfort of people inhabiting such structures. Noise is another aspect that, related to vibration, can also be other annoying aspect of comfort.



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Current Research

Dr. Dhakal's current involvements are with the research dealing with global, regional and urban carbon emissions and management, urban-wide integration of energy related policies in Asian mega and medium scale cities with considerable focus on urban transportation, energy-environment system modeling and policy analyses, urban metabolism, urban sustainability assessments and urban heat island mitigation strategies.

He is one of the two Executive Directors of the Global Carbon Project (www.globalcarbonproject.org). He leads the urban initiatives of the Global Carbon Project. Dr. Dhakal is also a Research Scholar of International Institute of Applied System Analyses (Austria), visiting Associate Professor of Nagoya University (Japan), and Senior Fellow of Institute for Global Environmental Strategies (Japan). He has authored over fifty scholarly publications including books, reports, book chapters, journal articles and others. He is a Senior Editor of *Carbon Management* and has been guest editor of special issues in *Energy Policy*, *International Journal of Pollution and Environment* and upcoming special issue in *Journal of Industrial Ecology*. He is member of editorial board of *Urban Climate* and *International Energy Journal*, and a regular reviewer of over fifteen reputed international journals in the field of sustainability, energy and emissions.

Dr. Dhakal is recently selected by IPCC as one of the Coordinating Lead Authors (CLA) of WGIII for the Chapter on Human Settlements, Infrastructure and Spatial Planning for the preparation of Fifth Assessment Report. He was also a Lead Author of urbanization section of Global Energy Assessment, an invited member of the Consensus Panel on Low carbon Cities of Academy of Sciences of South Africa, member of cities energy modeling group convened by the International Energy Agency, and expert of the Taskforce on Urban Development and Energy Efficiency of China Council for International Cooperation on Environment and Development.



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Research Keywords: Earthquakes, Soil Characterization, Slope stability, Geo-
synthetics, DEM modeling



Current Research

Drawing ancient topographical features of Osaka plain by using Geo-informatics Database

The preparedness of local and central governments in Japan for earthquake disaster mitigation is well praised worldwide. However, the recent earthquake and tsunami disaster at Tohoku area showed that there is much more to be done. In-depth study and preparations are therefore needed **for** the future likely shakings, such as Tonankai-Nankai earthquake, which is expected to invite even larger magnitude of disturbance along the pacific coast of West Japan. In this research, the consequences of the past tsunami invasions in Osaka plain is studied by analyzing the borehole log information and reproducing the geological structures of the period of interest based on the soil age and deposition.



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Research Keywords: Water quality, Deposited sludge, tides, Sustainable water environment,



Current Research

Dynamical behaviors of water quality in urban river with tidal change

Rivers have very high environmental value. The environmental status of any river anywhere indicates the environmental status of that region in the world. In the context of Japan, these rivers not only have environmental value but they also have high social, cultural and historical value. Hori River is one of the examples of that, which flows from north to south part through the downtown of Nagoya City, Japan. Present research has focused the detail water quality problems of this river. The relationship between water quality and living organisms are very important. Therefore, the main target of this research has the restoration and make for a sustainable of living organisms like fish.

This knowledge of present research should be practical application for the research of any urban River for its sustainability. Therefore, the title of this research “Dynamical Behavior of Water Quality in Urban River with Tidal Change” should address the water quality problems of Hori River, For instance, the relationship between deposition of sediment sludge and its bad smell for the sustainability of living organism inside the urban River. Moreover, Hori River is a manmade river and it has a negative impact on tide but the principle of this study on other urban rivers i.e. natural river could also be applicable. Therefore, this research has important role to link the dynamic behaviors of urban rivers for the restoration of their sustainability to the environment.



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Research Keywords: Hydrological modeling, climate change vulnerability and
adaptation in water, groundwater development and
management, virtual water and water footprint, GIS



Current Research

Characterize unsaturated zone soil hydraulic properties to estimate groundwater recharge in the Kathmandu Valley: field-, lab- and model-based investigations

Unsaturated zone soil hydraulic properties (SHPs) have an important control on groundwater recharge, water demand of vegetation and movement of pollutants into groundwater aquifers. However, characterizing SHPs by field experiments is resource-intensive and estimating it using pedotransfer functions (PTFs) needs evaluation of the PTFs and is associated with uncertainties too. My current research aims to characterize unsaturated zone soil hydraulic properties (SHPs) of groundwater aquifer in the Kathmandu Valley, calibrate and rank available PTFs to ensure their applicability for estimating the SHPs at other points, develop an advanced unsaturated zone flow model, and use it to estimate groundwater recharge along with uncertainties associated with the estimate. Field-, laboratory-, and model-based approaches would be used.