

Planning

The Water-Friendly Future



Forewords



Water is an essential element for all living creatures to survive on Earth. However, many rivers and lakes around us are suffering from various pollutions caused by human activities disregarding the nature's delicate systems in balance. In recent decades, development of cities have seriously distorted the water cycle resulting in frequent floods, dry streams and diffuse pollution.

Distortion of water cycle and diffuse pollution are mainly caused by the development methodology that takes account of the economic benefit first and neglect the potential deterioration of the water environment. Therefore, the water-related environmental problems can be better approached by adopting water-friendly development methodology that considers the water environment first.

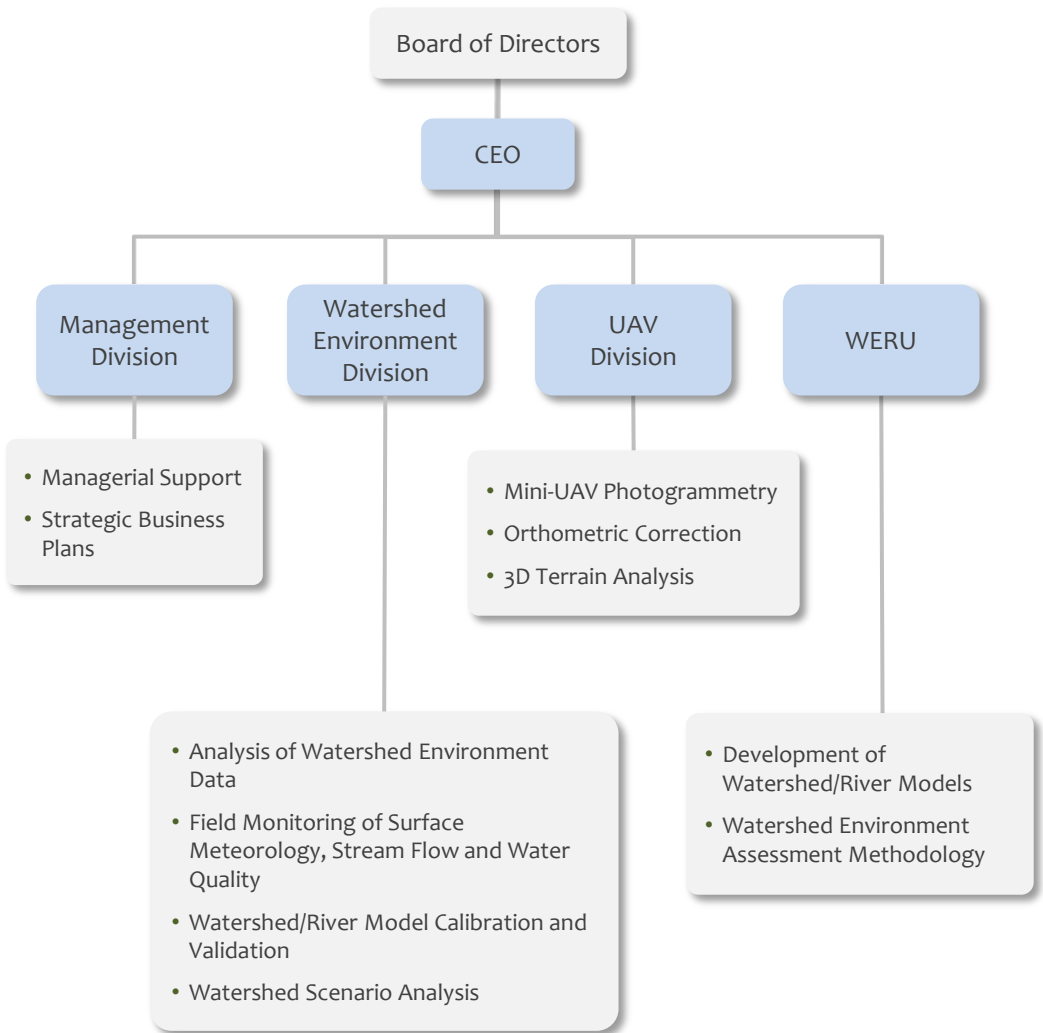
By using state-of-the-art technology, we will do our best to find feasible and sustainable ways to mitigate the distortion of the water cycle processes and to design a water-friendly environment in our watersheds. We hope our efforts contribute to make our environment better so that our sons and daughters would enjoy clean water and pleasant environment.



Thank you very much for your interest and support.

Hong-Lae Cho, PhD.
CEO, HydroCore Ltd.

Organizational Structure



History

| | | |
|-------------|----------------|---|
| 2017 | 12 | Developed STREAM 2.0 , a hybrid watershed model |
| 2016 | 10 03 | Developed SNIFE 1.0 , a large-scale watershed model Dr. HL Cho inaugurated as the 2 nd CEO |
| 2015 | 10 | Developed REDPOLL 1.0 , a watershed pollution loading model |
| 2013 | 04 | Registered as a Ultra-Light UAV Photogrammetry Service Company |
| 2011 | 10 09 | Developed CAMEL 3.0 , a distributed watershed model Developed STREAM 1.0 , a hybrid watershed model |
| 2010 | 11 05 02 | Registered as a Software Business Company Registered as an Engineering Company (Water Quality Management) Certified as a Research & Development Service Company |
| 2009 | 06 03 | Installed WERU (Watershed Environment Research Unit), an in-house lab. Certified as a Venture Company |
| 2008 | 12 01 | Developed CAMEL 2.5 , a distributed watershed model Aero photogrammetry service using a mini-UAV started |
| 2007 | 11 | Developed RoadStorm 2.0 , a road diffuse pollution model |
| 2006 | 12 10 | Developed CAMEL 2.0 , a distributed watershed model Developed RoadStorm 1.0 , a road diffuse pollution model |
| 2005 | 12 | HydroCore Ltd. established and Dr. BK Koo inaugurated as the 1 st CEO |

Introduction

What is Diffuse Source Pollution?

Diffuse source pollution is caused when pollutants from a range of dispersed urban and rural land use activities contaminate our waterways. An important characteristic of diffuse source pollution is that it can be caused by a variety of activities that have no specific point of discharge. Agriculture is a key source of diffuse source pollution, but urban land, forestry, atmospheric deposition and rural dwellings can also be important sources. By its very nature, the management of diffuse source pollution is complex and requires careful analysis and understanding of various natural and anthropogenic processes.



Our Business Areas

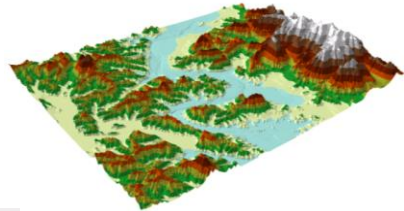
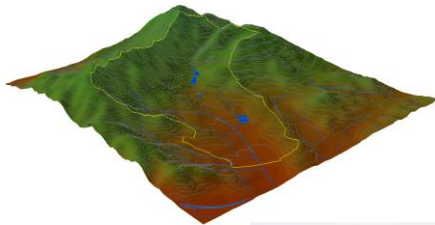
Based on professionally trained expertise in diffuse source pollution analysis and management, HydroCore provides invaluable consulting and engineering services on the following areas:

- ✓ Geographic Data Analysis
- ✓ Field Monitoring of Stream Flows and Water Quality
- ✓ Watershed Modelling
- ✓ River Flow Modelling
- ✓ UAV Photogrammetry



Data Analysis and Field Monitoring

The hydrological and biogeochemical processes in a watershed are affected by meteorological and environmental factors such as terrain, soil, geology, vegetation and land use which are interrelated to one another. In order to understand the diffuse source pollution of a watershed, therefore, it is essential to carry out data analysis at the watershed scale. HydroCore provides customized services of geographic data analyses and field monitoring of stream flows and water quality based on extensive field experiences.



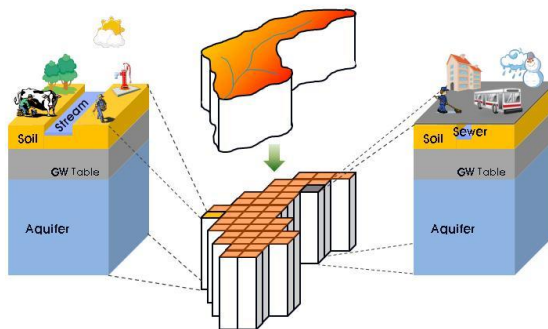
Watershed Modelling

A watershed model is a computer software system that can be used: (i) to analyze the spatio-temporal distribution of diffuse source pollution from a global perspective; and (ii) to predict the impact of various environmental changes.

HydroCore is recognized as one of the best watershed modelling groups in Korea and it has been supported by Korean government bodies such as the Ministry of Environment, the Ministry of Maritime Affairs and Fisheries and the Rural Development Administration to develop watershed models suitable for applying to the Korean watersheds.

Since 2005, HydroCore has developed a series of watershed models that can be used for various purposes:

- ✓ **CAMEL** (Chemicals, Agricultural Management and Erosion Losses)
- ✓ **STREAM** (Spatio-Temporal River-basin Ecohydrology Analysis Model)
- ✓ **SNIFE** (Subsurface Nitrogen Pollution Evaluation)
- ✓ **REDPOLL** (Regional Estimation of Diffuse POLLution Loads)



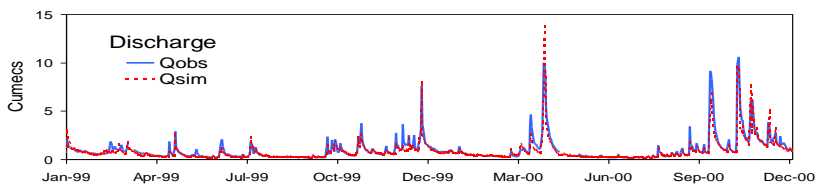
Conceptual structure of the distributed watershed model CAMEL

Watershed Model: CAMEL

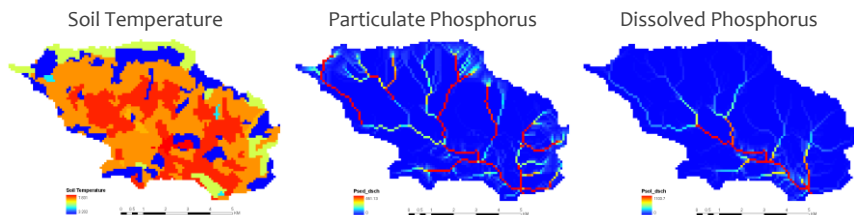


CAMEL is a fully-distributed, physically-based watershed model to simulate hydrologic and biogeochemical processes using a network of square grid cells. The model simulates surface water and groundwater interactions and requires relatively high computational cost. CAMEL is suitable for applying to small catchments where individual processes need to be examined in detail.

- ✓ Hydrologic and biogeochemical processes
- ✓ Stream flow and groundwater dynamics
- ✓ Transformations of carbon, nitrogen and phosphorus
- ✓ Transport of water, sediment and nutrients
- ✓ Calculation time step: 1 min. – 1 hour



Simulated and observed hydrographs at the outlet of the Tarland Burn Catchment, UK



Soil temperature and phosphorus transport across the Tarland Burn Catchment, UK

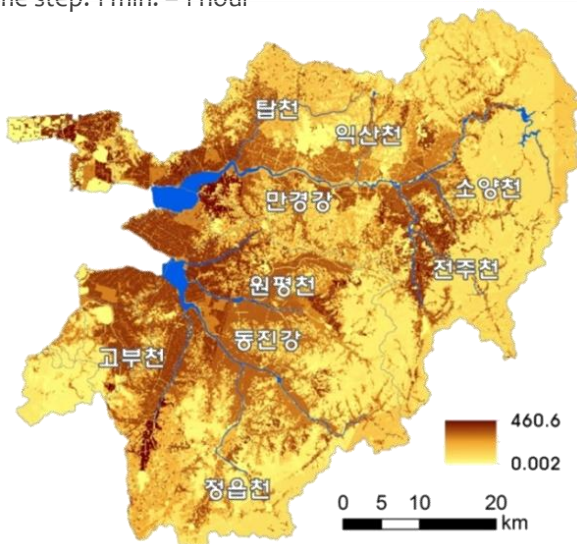
Watershed Model: STREAM



STREAM is a hybrid watershed model that is mainly based on physically-based approaches. The model simulates hydrologic and biogeochemical processes using a network of square grid cells.

Conceptual approaches are employed in the model to simulate river flow and groundwater discharge. STREAM is suitable for applying to medium to large watersheds for various watershed management purposes.

- ✓ Hydrologic and biogeochemical processes (physically-based approaches)
- ✓ River flow and groundwater discharge (conceptual approaches)
- ✓ Transformations of carbon, nitrogen and phosphorus
- ✓ Transport of water, sediment and nutrients
- ✓ Calculation time step: 1 min. – 1 hour



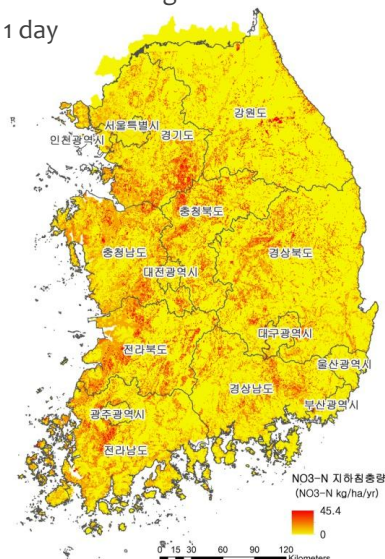
Annual TOC loading rates (kg-C/ha/yr) within the Saemankeum Watershed

Watershed Model: SNIPE



SNIPE is a relatively simple hybrid watershed model. The model simulates hydrologic and biogeochemical processes using physically-based equations, but simulates groundwater discharge conceptually and ignores river channel routing processes. The model represents a watershed using a set of square grid cells. SNIPE is designed to be used for estimating nitrogen pollution loads leaching from soil to groundwater at the regional- or national-scale.

- ✓ Hydrologic and biogeochemical processes (physically-based approaches)
- ✓ Groundwater discharge (conceptual approach)
- ✓ No river channel routing processes
- ✓ Transformations of carbon and nitrogen
- ✓ Calculation time step: 1 day



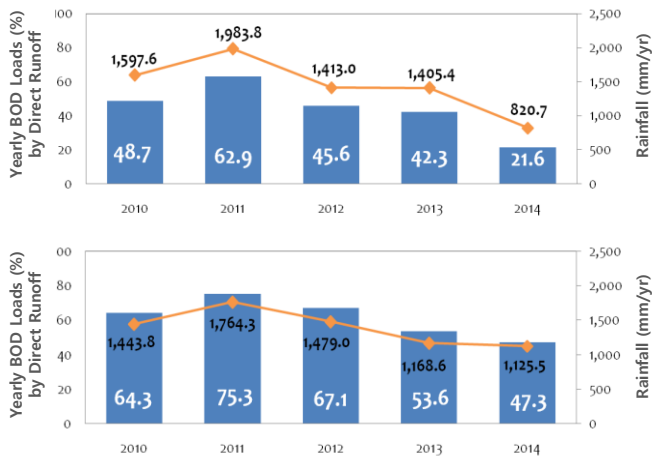
Annual leaching rates of nitrate from soil to groundwater in Korea (kg-N/ha/yr)

Watershed Model: REDPOLL



REDPOLL is a simple conceptual watershed model that represents a watershed using a set of square grid cells. For each of the grid cells, the model applies conceptual equations to simulate major hydrologic processes including evapotranspiration, infiltration, direct runoff and base flow taking into account surface slope, soil texture and land use of the grid cell. It also estimates diffuse source pollution loadings from a grid cell by applying the EMC (Event Mean Concentrations) for the land use of the grid cell. REDPOLL is designed to be used for estimating diffuse source pollution loads at the regional- or national-scale.

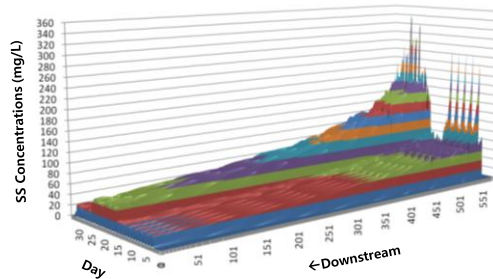
- ✓ Major hydrologic processes (conceptual approach)
- ✓ EMC-based diffuse source pollution loads
- ✓ Calculation time step: 1 day



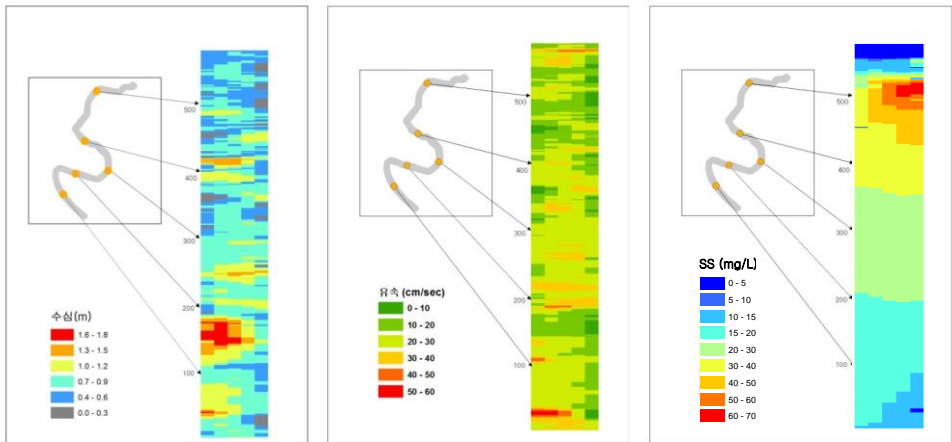
Yearly BOD loads contributed by the direct runoff process:
the River Han Watershed (top) and the River Nakdong Watershed (down)

River Flow Modelling

Simulating detailed movements of water and sediment in rivers is required for environmental impact assessment of human activities such as sediment dredging or river structure installation. HydroCore provides river flow modelling services to simulate the spatial distribution of river flows, sediment transport and river water quality using river models such as HEC-RAS and EFDC.



Simulated SS conc. over time and downstream distance of the River Nakdong



Simulated flow depth, velocity and SS conc. for a reach of the River Nakdong

UAV Photogrammetry

In recent years, small Unmanned Aerial Vehicles (UAVs) equipped with automatic navigation systems have been used for aerial photogrammetry and for various environmental analysis purposes. The resolution of an UAV aerial image with 4 cm pixels is 400 times higher than a satellite image with 1 m pixels and 14 times higher than a traditional aerial image with 15 cm pixels. UAVs have the advantage of being able to acquire high resolution aerial images of the target area immediately when needed (on-demand image). Using small UAVs, HydroCore provides state-of-the-art services to acquire, analyze, and build a database of high resolution aerial images that are enormously useful for watershed and river management.



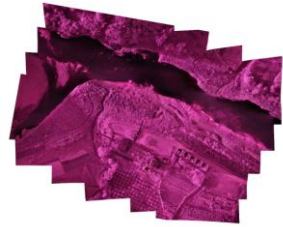
UAV Photogrammetry

Utilization of UAV Images:

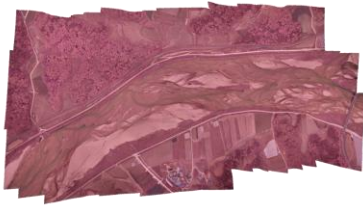
- ❖ Analysis of river/lake environment
 - ✓ Geomorphologic changes in the river channel
 - ✓ Outbreaks of harmful algal blooms (HABs)
 - ✓ Vegetation distribution (GI, NDVI etc.)
 - ✓ Distribution of large birds (ducks, cranes etc.)
- ❖ Database of high-resolution aerial images
 - ✓ River/lake ecosystem research
 - ✓ Seasonal/annual records of the environment



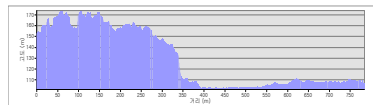
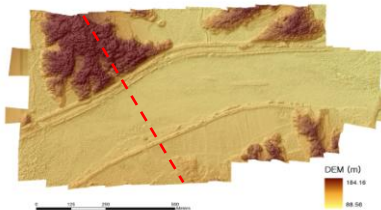
RGB Image of the River Seom



NIR Image of the River Seom



Orthorectified Image of the River Naesung



DSM and channel cross-section of the River Naesung

Water is the core element (hydrocore) that underpins the whole ecosystem of the Earth.



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