COMPLUTENSE INTERNATIONAL COURSE (C.I.C.)

LANDFORM DESIGN AND MODELLING FOR BEST PRACTISE IN MINE REHABILITATION

Director – Prof. José F. Martín Duque (Complutense University, Spain)
Secretary – Roderick M. Eckels (Landforma, Australia)
Lecturers – Prof. Gregory R. Hancock (University of Newcastle, Australia), Nicholas Bugosh (GeoFluv, United States)
Assistant: Néstor Hernando (Complutense University, Spain)
Dates Sept 18 – 21, 2018; Hours: 28
Place: Faculty of Geology, Complutense University, Madrid, Spain
Number of participants – 40

Upper left: 3D perspective view of the GeoFluv computer-aided design (CAD) made using Natural Regrade for a large out-of-pit waste material pile (La Plata, New Mexico, US). Lower left: image of the same large out-of-pit waste material pile immediately after construction grading and application of top-dressing material, but before vegetation has sprouted, seen from a different perspective. Upper right: GeoFluv landform design at Drayton mine (New South Wales, Australia). Lower right, 100-yr SIBERIA modelling of the same area.

Co-organizers

Sponsors

Collaborators
AIM OF THE COURSE

Help promoting Fluvial Geomorphic Design and Landscape Evolution Modelling, by qualified training, for current and future Best Practice in Mine Rehabilitation, at an international level.

INTRODUCTION

Mining is necessary for maintaining society's current lifestyle and facilitating future growth and will continue to develop at a global scale, because even if the use of some mineral resources may decline (such as coal), the need for other minerals for emerging technologies will concurrently grow. The generation of solid and liquid wastes and the discharge of these wastes onto land and into waterways are arguably the greatest impacts on the environment associated with mining. The science of Geomorphology provides the best framework for understanding and quantifying stability and changes in erosion and sedimentation, which is the root of the wastes’ release to the environment at any disturbed mine site. When fluvial geomorphic processes are integrated for designing and building steady state and functional landforms, the mine-rehabilitated lands can perform like stable natural ones. This process is enhanced by using Landscape Evolution Models (LEM) that simulate the geomorphic evolution of landforms subjected to fluvial erosion and mass transport processes. LEM use widely accepted hydrology and erosion models under the action of runoff and erosion over variable-time scales. Current worldwide cutting-edge best practice and research in disturbed mine rehabilitation tries to merge methods and packages for landform design and landscape evolution modelling, increasing their capabilities. This course will focus on an introduction of what are considered some of the best available techniques, on a global scale, for Fluvial Geomorphic Design (GeoFluv – Natural Regrade) and LEM SIBERIA for best practice in mine rehabilitation. The course has a strong practical emphasis, almost totally focused in the use of specific dedicated software, taught by the best experts worldwide. It is completed with lecturers about THE state of art of geomorphic mine rehabilitation, globally, and about GPS machine guidance for geomorphic reconstruction in mine rehabilitation. Field work, a panel of discussion and networking activities complement the proposal.

LECTURERS AND TRAINERS

Greg Hancock, Associate Professor at the University of Newcastle (Australia). Greg made his Ph.D. on the use of the SIBERIA model under the supervision of Professor Garry Willgoose, inventor of the Landscape Evolution Model SIBERIA. He has more than 25 years of experience in the use of SIBERIA, and he is one of the most influential authors worldwide in the field of landform stability in mine rehabilitation. He also masters the use of other Landscape Evolution and Soil Erosion models.

Nicholas Bugosh, Principal of the GeoFluv company (www.geofluv.com, United States). Nicholas Bugosh is the inventor of the patented and widely-acclaimed GeoFluv method and the Natural Regrade software. He is, therefore, the best expert, worldwide, in this technique, which has been identified as Best Available Technique for Mine Rehabilitation both in the US and at the EU.

José F. Martín Duque, Associate Professor at the Complutense University of Madrid, Spain. His extensive work has included design, modelling, monitoring and publishing in erosion and geomorphic rehabilitation of mined lands since 1995. He directs a specialized research and technology-transfer university group (www.restauraciongeomorfologica.es) on this topic and teaches it for two master programs. José has led many projects in this field, and has lectured about this innovative discipline, in many different countries.

Rod Eckels, graduate and master in Surveying, is specialized in applying high-accuracy GPS to surveying applications. In 1987, Rod joined Leica Geosystems, to promote and support their range of GPS surveying equipment in the Australasian region. In 1997, Rod moved to California with Leica, where his role was to
develop new applications for GPS in machine guidance and control systems. He then met Nicholas Bugosh, who was implementing the GeoFluv approach at the BHP La Plata open pit mine in New Mexico. In 2006, he started “Landforma” to promote the Fluvial Geomorphic approach to land rehabilitation in Australia.

**PROGRAM**

**Schedule (September 2018) Schedule**

<table>
<thead>
<tr>
<th>Time</th>
<th>Tuesday 18th</th>
<th>Wednesday 19th</th>
<th>Thursday 20th</th>
<th>Friday 21st</th>
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<tbody>
<tr>
<td>8:30 – 9:30</td>
<td>Welcome. Academic Authorities Opening Lecture</td>
<td>Lecture on GPS Machine Guidance</td>
<td>Field work (i): Geomorphic mine rehabilitation examples at the kaolin mines of the Alto Tajo region</td>
<td>Field work (ii): Examples in guided tour around Madrid</td>
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<td>9:30 – 11:00</td>
<td>GeoFluv-Natural Regrade (G1) LEM-SIBERIA (G2)</td>
<td>GeoFluv-Natural Regrade (G2) LEM-SIBERIA (G1)</td>
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<td>11:00 – 11:30</td>
<td>Morning coffee break</td>
<td>Morning coffee break</td>
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<tr>
<td>11:30 – 13:30</td>
<td>GeoFluv-Natural Regrade (G1) LEM-SIBERIA (G2)</td>
<td>GeoFluv-Natural Regrade (G1, NB) LEM-SIBERIA (G1)</td>
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<td>13:30 – 15:00</td>
<td>Lunch</td>
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<tr>
<td>15:00 – 16:30</td>
<td>GeoFluv-Natural Regrade (G1) LEM-SIBERIA (G2)</td>
<td>GeoFluv-Natural Regrade (G1, NB) LEM-SIBERIA (G1)</td>
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<td>16:30 – 17:00</td>
<td>Afternoon coffee break</td>
<td>Afternoon coffee break</td>
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<tr>
<td>17:00 – 18:30</td>
<td>GeoFluv-Natural Regrade (G1) LEM-SIBERIA (G2)</td>
<td>Round table</td>
<td>Course Dinner</td>
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**PROGRAM**

1. *Geomorphologic mine rehabilitation. State of art at a global scale.* Opening lecture. Prof. José F. Martín Duque (Complutense, University, Spain)
2. *Fluvial geomorphic landform design for best practice in mine rehabilitation. The GeoFluv method and the Natural Regrade software.* Nicholas Bugosh (GeoFluv, United States)
4. *GPS machine guidance for fluvial geomorphic landform reconstruction in mine rehabilitation.* Rod Eckels (Landforma, Australia)

**Detailed contents for GEOFLUV – NATURAL REGRADE (Fluvial geomorphic landform design for best practice in mine rehabilitation. The GeoFluv method and the Natural Regrade software) – Nicholas Bugosh**

**9:30 – 11:00**

Setup, load example files (will determine during course of training if updates are needed)

Explanation about software functions, PowerPoint overview of GeoFluv™ approach (include Essentials), introductory remarks about training goals and paradigm shift

Carlson Software / AutoCAD package overview

**General Menu**

- File: clipboard/copy with basepoint, drawing cleanup
- Layer Properties Manager: on/off, freeze/thaw, new layer, layer colors
- Edit: Erase/select, by layer, by closed polyline, Offset/standard offset, Break/ by crossing polyline, at selected point, Polyline Utilities/reduce vertices, edit polyline/add polyline vertex
- View: Extents, 3D viewer window, Surface 3D viewer, change layer, freeze layer
• Inquiry: list, layer ID
• Settings: Carlson configuration, AutoCAD options, Carlson menus
• Points: draw/locate points, import text/ASCII file, crd file
• Draw Polyline, 2D vs. 3D polyline, close polyline, erase, draw circle,
  Commonly used tools
  • drag vertices, drag polyline, read elevation from vertices, object snaps, ortho, distance
  (type: dist)

Civil Menu

• 3D Data: Edit/Assign Polyline Elevations, 2D to 3D Polyline, 3D polyline utilities/offset 3D
  polyline
• Surface: Volumes by Triangulation

11:30 – 13:30

Natural Regrade demonstration (Regrade 1) without explanation of commands
Class runs through Regrade 1 example
Explain ‘Design GeoFluv Regrade’ dockable dialog box commands
Explain ‘Channels’ tab
  • displayed information only relevant to channel in ‘Current Channel’ window
  • channels and subwatersheds are designed at this point, show profile
  • naming convention
  • ‘Add’ all channels, explain interactive dialog
  • drainage density update
  • generate channel ‘Report’
  • explain ‘Reread Valley Bottoms’
Explain ‘Output’ tab
  • the design output is the result of the inputs (garbage in, garbage out), changes to the
    drawing do not change the inputs (DWG tab next)
  • ‘Preview’ allows cursory inspection to make major edits before proceeding, demonstrate
    adding channel bend
  • ‘Draw Design Surface’ outputs the draft design as a drawing, explain ‘Triangulate and
    Contour’ dialog box
  • explain contouring inspector
  • show completed draft Regrade 1 design
  • review ‘Summary Report’
  • return to Natural Regrade menu and demonstrate ‘GeoFluv Channel Inspector’
Explain ‘DWG’ tab
  • demonstrate ‘GeoFluv Contour Viewer’
  • demonstrate ‘GeoFluv Design Viewer’
  • return to ‘Output’ tab and run ‘Update Cut / Fill’
  • run ‘Cut/Fill Centroids’
  • compare ‘Channels Cross Section Report’ with ‘Channels’ tabs ‘Report’
  • demonstrate ‘View Longitudinal Profile’
  • demonstrate ‘Edit Longitudinal Profile’
  • demonstrate ‘Auto Longitudinal Profile’
  • explain ‘Save Design Surface .tin’, this is format for direct output to machine control
15:00 – 16:30

Return to ‘Channels’ tab, explain ‘Current Channels Settings’

Class returns to Regrade 1 example and varies settings to user’s estimated project and other site values, produce different draft alternatives

Compare and discuss example alternatives, Open question and answer / discussion

Review input values in order of importance, review ‘Essential GeoFluv Concepts’

Design Regrade 1 with different values in each subwatershed, search for optimal solution

Discuss results

17:00 – 18:00

Address key issues, discuss planning, timing, construction (equipment, machine control, channel roughness, perennial streams, etc.)

Open discussion

Laying out pilot change for staged design with GeoFluv projects

- Make base .tin
- Set GeoFluv boundary
- Draw pilot channel
- Estimate and draw GeoFluv project boundaries
- Draw Design Surface
- Record key parameters at project boundaries for transition: elevation, slope, Q peak bankfull, Q peak FP

Resume

- Make GeoFluv project channel input lines
- Run Design GeoFluv Regrade, Save As project, save design lines GF channels & GF ridges to new project layers
- Make next project
- Use GeoFluv Channel Inspector tool to look for problems, tractive force, slope
- Make complete .tin
- Use Runoff Tracking to inspect design
- Make necessary edits to design to finalize
- Review Essential GeoFluv
- Review five inputs in order of importance
- Work on areas of special interest

Detailed contents for SIBERIA – LEM – Greg Hancock

9:30 – 11:00

Overview of LEM

Model input and capabilities

Digital elevation model
Hydrology and sediment transport data for calibration
Rainfall data (event based)
Soil information (particle size...)

11:30 – 13:30
OVERVIEW OF SIBERIA
3-D topographic evolution model
Simulation of runoff, erosion, deposition at annual time steps
Prediction of long-term channel and hillslope development
Run time – minutes to hours

OVERVIEW OF CAESAR (Catchment Automaton Evolutionary Slope And River model)
3-D topographic evolution model
Simulation of runoff, erosion, deposition
Use input data from discrete (hourly) rainfall and runoff events, enabling the effect of extreme rainfall events on landform stability to be simulated
Run time – days to weeks

15:00 – 16:30
EXAMPLES
CASE 1 - ERA Ranger uranium mine (Australia)
CASE 2 – DRAYTON MINE (AngloAmerican, Australia)

17:00 – 18:00
Overview
Calibration
Is the model parameterisation correct?
Issues with predicting the landform state in 100 years (and longer!)
Materials weather and surfaces armour!
The ultimate landscape evolution model - Goal being a LEM that predicts not just hillslope and catchment form - but soil horizons

Detailed contents of field work
Field work in the kaolin mines located at the edge of the Alto Tajo Natural Park area (Peñalen and Poveda municipalities), analyzing the following contents

- Severe gully erosion at the Santa Engracia mines with traditional, poor standard, mine reclamation measures
- Stable traditional landforms at the Machorro mine
- The use of concave slopes and topsoil at the experimental spoil heap of El Machorro
- GeoFluv – Natural Regrade mine rehabilitations at the El Machorro, Maria Jose and Nuria kaolin mines.

Field work around Madrid with similar contents

**Profile of expected participants**

University students, graduated and master related with environment and mining, and all types of professionals and administrative staff involved with mine rehabilitation-restoration, all of them highly motivated with increasing the standard of practice.

**Language**

The whole course will be taught in English.

**Participants**

There are 20 seats for university students or unemployed graduates and master professionals, with a registration fee of 400 €, and 20 seats for professionals and administrative staff, with a registration fee of 1000 €. In both cases, registration includes course enrollment, coffee and lunch allowance, course dinner, field work visit (bus and lunch) and guided walking tour of Historical Madrid. If any of the 20 seats for each category is not completed, it will be open to the other category.

* Tuition pending, to be confirmed.

This 28h course is equivalent to a 2 credits course, only for UCM enrolled students.

**Location**

Assembly hall and computer labs of the Faculty of Geology, Complutense University of Madrid, Calle Jose Antonio Novais 2, 28040 Madrid, Spain (40.448871, -3.725714)

**Only Registration**

For concerns and issues regarding online registration, please contact General Foundation UCM Department of Information and Registration: mafgucm@ucm.es. Phone (+34) 913948408. Monday through Friday, 9:00 – 14:00.