UNIVERSITY MASTER PROGRAM IN ECOSYSTEM RESTORATION
http://www3.uah.es/master_rest_eco/

Syllabus - GEOMORPHIC RESTORATION

6 ECTS. Academic year 2024 – 2025 (January, 2025)

CONTENTS

Theory

1. Earth movement and Global Change
2. Relationships between geology, geomorphology and ecological restoration.
3. Evaluation and diagnosis of geomorphic effects, and changes in runoff and erosion and sedimentation balance, caused by human activities implying earth movements (mining, civil works, urban developments…)
4. Fluvial geomorphic restoration. Historical evolution. Main methods, techniques and software. Construction procedures. Examples. Monitoring and critical assessment.
5. Methods for geomorphic restoration of hard-rock settings
6. Landscape Evolution Models
7. Basic concepts for soils and surficial deposits handling in geomorphic restoration.
8. Geomorphic restoration for different human activities. Geolandscaping.

Practical skills

1. Being able of using professional tools of CAD involved in terrain engineering and earth movements.
2. Make basic fluvial geomorphic restoration designs in the framework of ecological restoration projects that need such approach. Specifically, by using the GeoFluv method - Natural Regrade *software*.
3. Introduction to the use of landscape evolution models (LEM), capable to forecast the erosive evolution of different restoration designs. Explicitly, by using the SIBERIA LEM.

LECTURERS

- José F. Martín Duque (theory and lab), Faculty of Geology, Complutense University of Madrid.
- María Tejedor Palomino. Faculty of Geology, Complutense University of Madrid.

TEACHING ORGANIZATION AND CLASSROOMS

Nine four-hour classroom sessions, one day of field work and one day of exam. All classroom sessions include theory and practise, focused on practise by the use of CAD-based geomorphic landform design software. All classes (outside January 17th, 10:00 to 11:30, see below) will be taught at the Automatic Mapping Computer Lab classroom (1st floor, by the elevators of the right wing of the building) of the Geological Sciences Faculty. For the first day, in case of doubt, ask at the Concierge of the Faculty of Geology (ground floor). Since this subject is uninterruptedly taught, we will not use any Virtual Campus. All the materials (pdf of presentations, papers…) will be available at the computers of the Lab class.

GRADING SYSTEM

Attending to the face-to-face classes is compulsory. Since the teaching is concentrated in two weeks, just before the exams period, the grading will consist in:

(a) a final exam, broad enough to reduce uncertainty for the student, consisting in: (a1) questions on benchmark papers (highlighted at the references section) on geomorphic restoration (10% of the final mark); (a2) questions and short exercises on all the theoretical and practical contents of the subject (60 % of the final mark); (a3) short questions on the field work (10% of the final mark).
(b) Basic design of a real case, by the student (individual), developed during three days of classes and home-work (20% of the final mark). To be sent to the lecturer up to February 6th, 2024.

SCHEDULE AND CONTENTS – all classes from 10:00 to 14:00, computer Lab, Faculty of Geology UCM

Session I. Wednesday, January 8, 2025
1. 10:00 to 11:30. Course organization. *Theory*. Earth movement and global change **(ppt1)**.
2. 11:50 to 14:00. *Practise*. (1) Introduction to AutoCAD and Carlson software. (2) Drainage basin analysis within CAD (divides, ridgelines and talwegs).

Session II. Thursday, January 9 2025
1. 10:00 to 11:30. *Theory*. Geomorphology and ecosystem restoration **(ppt2)**.
2. 11:50 to 14:00. *Practise*. Basic exercises in CAD: (1) basic morphometric analysis of drainage basins. (2) conventional topographic designs (pads).

Session III. Friday, January 10, 2025
1. 10:00 to 11:30. *Theory.* Conventional landform design (in earth movement's construction and restoration). Geomorphology and erosion of areas disturbed by earth movements **(ppt3).**
2. 11:50 to 14:00. *Practise*. Tutorial on the GeoFluv method and Natural Regrade software. General settings.

Session IV. Monday, January 13, 2025
1. 10:00 to 11:30. *Theory*. Fluvial geomorphic restoration. The drainage basin as basic restoration unit **(ppt4)**.
2. 11:50 to 14:00. *Practise*. Tutorial on the GeoFluv method and on the Natural Regrade software. Channel settings.

Session V. Tuesday, January 14, 2025
1. 10:00 to 11:30. *Theory*. The GeoFluv – Natural Regrade method **(ppt5)**. The Canadian geomorphic approach **(ppt6)**. The Australian (hybrid) method **(ppt7)**.
2. 11:50 to 14:00. *Practise*. Tutorial on the GeoFluv method and on the Natural Regrade software. Cut and fill balances. Slope gradients. Runoff tracking.

Session VI. Wednesday, January 15, 2025
1. 10:00 to 11:30. *Theory*. Construction of GeoFluv-Natural Regrade based restorations **(ppt8)**. Examples **(ppt9)**.
2. 11:50 to 14:00. *Practise*. Geomorphic landform design of a real case (I).

Session VII. Thursday, January 16, 2025
1. 10:00 to 11:30. *Theory*. Monitoring and assessment of fluvial geomorphic restorations **(ppt10)**. Methods for geomorphic restoration of hard-rock settings (mine highwalls or roadcuts). UK method and Talus Royal **(ppt11)**.
2. 11:50 to 14:00. *Practise*. Geomorphic landform design of a real case (II).

Session VIII. Friday, January 17, 2025
1. 10:00 to 11:30. *Theory.* Soil and surficial deposits handling in geomorphic restoration **(ppt12)**. Landscape Evolution Models (LEM) **(ppt13).**
2. 11:50 to 14:00. *Practise.* Basic use of SIBERIA and EAMS software.

Session IX. Monday, January 18, 2025
1. 10:00 to 11:30. *Theory.* Geomorphic restoration in linear infrastructures and urban developments. Geolandscaping **(ppt14).**
2. 11:50 to 14:00. *Practise*. Geomorphic landform design of a real case (III).

Session X. Tuesday, January 21, 2025. FIELD WORK

Visit to the Santa Engracia mine (Peñalén, Guadalajara). This abandoned mine has been ecologically restored based on a geomorphic approach, in the framework of a LIFE (RIBERMINE) project of the European Union. The forecasted time for departing, from the Faculty of Biology of the UCM, will be 7:45 am. There will be an intermediate stop in Guadalajara, but not in Alcalá. The forecasted time of arrival to Madrid is 19:00. Before the field trip, it is recomended watching the videos at https://liferibermine.com/es/galeria-tecnica/. Logistic details will be provided on Friday 17 of January, 2025.

REFERENCES

The references listed below will be available for the student at their computers at the class, outside of the books, available at the Library of the Faculty of Geology. Given the fact that Geomorphic Restoration is still a young discipline, there are no good and specific handbooks, or books, yet. The following list is a selection of the most outstanding and updated literature. Reading all of them neither is needed to pass the subject nor is expected, given also the short period of time between the beginning of the subject and the evaluation. However, the papers highlighted (in bold) must be read, since there will be questions on them at the examination (10% of the final mark).

Basha, N.A, Eplényi, A., Sándor, G. 2021. Inspirative Geology - The Influence of Natural Geological Formations and Patterns on Contemporary Landscape Design. Landscape Architecture and Art, 17(17), 39-48.

Bugosh, N., Epp, E. 2019. Evaluating sediment production from native and fluvial geomorphic reclamation watersheds at La Plata Mine. Catena, 174: 383-398.

Environment Australia. 1998. Landform Design for Rehabilitation. Department of the Environment, Canberra.

Gunn, J., Bailey, D. 1993. Limestone quarrying and quarry reclamation in Britain. Environmental Geology 21:167-172.

Hancock, G. 2004. The use of landscape evolution models in mining rehabilitation design. Environmental Geology 46:561–573.

Hancock GR, Willgoose GR. 2018. Sustainable Mine Rehabilitation – 25 Years of the SIBERIA Landform Evolution and Long-term Erosion Model, Australian Institute of Mining and Metallurgy.

Hancock, G.R., Martín Duque, J.F., Willgoose, G.R. 2019. Geomorphic design and modelling at catchment scale for best mine rehabilitation – the Drayton mine example (New South Wales, Australia). Environmental Modelling and Software 114: 140 151.

Hancock, G.R., Martin Duque, J.F., Willgoose, G.R. 2020. Mining rehabilitation - using geomorphology a engineer ecologically sustainable landscapes for highly disturbed lands. Ecological Engineering 155, 105836.

Hannan, J.C. 1984. Mine Rehabilitation. A Handbook for the Coal Mining Industry. New South Wales Coal Association, Sydney, 124 pages. (Second edition of 1995).

Hooke R, Martín Duque JF, Pedraza J. 2012. Land transformation by humans. GSA Today 22 (12): 4–10.

Hooke, R.L., Martín Duque, J.F., 2021. Impact of the Great Acceleration on Our Life-Support Systems. In: Shroder, J.J.F. (Ed.), Treatise on Geomorphology, vol. 9. Elsevier, Academic Press, pp. 167–186. https://dx.doi.org/10.1016/B978-0-12-818234-5.00035-3.

Humphries, R.N. 1977. A new method for landscaping quarry faces. Rock Products, 80(5), 122H-122J.

Humphries, R.N. 1979. Landscaping hard rock quarry faces. Landscape Design, 127, 34-37.

Legwaila, I., Lange, E., Cripps, J. 2015. Quarry reclamation in England. A Review of Techniques. Journal American Society of Mining and Reclamation, 4, 55-79.

Martín Duque, J.F., Sanz, M.A., Bodoque, J.M., Lucía, A., Martín, C. 2010. Restoring earth surface processes through landform design. A 13-year monitoring of a geomorphic reclamation model for quarries on slopes. Earth Surf. Proc. Landforms, 35: 532-548.

Martín Duque, J.F. 2024. Restauración Geomorfológica (bloque temático 13). En: Restauración Ecológica. Bases técnicas y soluciones prácticas, pp. 100-110. Fundación Biodiversidad. Ministerio para la Transición Ecológica y el Reto Demográfico (en prensa).

Martín Duque, J.F., Tejedor, M., Martín Moreno, C., Nicolau, J.M., Sanz Santos, M.A., Sánchez Donoso, R., Gómez Díaz, J.M. 2020. Geomorphic landscape design integrated with progressive mine restoration in clay quarries of Catalonia. International Journal of Mining, Reclamation and Environment, 35(6), 399-420.

Martín Duque, J.F., Zapico, I., Bugosh, N., Tejedor, M., Delgado, F., Martín-Moreno, C., Nicolau, J.M. 2021. A Somolinos quarry land stewardship history: From ancient and recent land degradation a sensitive geomorphic-ecological restoration and its monitoring. Ecological Engineering, 170, 106359, 1-18.

Martín-Moreno, C., Martín Duque, J.F., Nicolau, J.M., Hernando, N., Sanz, M. and Castillo, L. 2016. Effects of topography and surface soil cover on erosion for mining reclamation. The experimental spoil heap at El Machorro mine (Central Spain). Land Degradation & Development 27: 145-159.

Martín-Moreno, C., Martín Duque, J.F., Nicolau, J.M., Muñoz, A., Zapico, I. 2018. Waste dump erosional landform stability – a critical issue for mountain mining. Earth Surf. Process. Landf. 43: 1431–1450.

Nicolau, J.M. 2003a. Trends in relief design and construction in opencast mining reclamation. Land Degradation and Development 14: 215-226.

Nicolau, J.M. 2003b. Diseño y construcción del relieve en la restauración de ecosistemas degradados: una perspectiva ecológica En: Rey Benayas et al. (Eds), Restauración de Ecosistemas en Ambientes Mediterráneos, pp. 173-188, Universidad de Alcalá, Alcalá de Henares.

Rosgen, D.L. 1994. A classification of natural rivers. Catena, 22:169-199.

Rosgen, D.L. 1996. *Applied River Morphology*. Wildland Hydrology, Pagosa Springs, Colorado.

Sawatsky, L., Beckstead, G. 1996. Geomorphic approach for design of sustainable drainage systems for mineland reclamation. International Journal of Mining, Reclamation and Environment 10(3): 127-129.

Sawatsky, L.F., Beersing, A., Ade, F. 2008. Configuration of Mine Closure Landforms — Geomorphic Approach. A.B. Fourie, M. Tibbett, I.M. Weiersbye, P.J. Dye (eds), Mine Closure 2008, Australian Centre for Geomechanics, Perth.

Sawatsky, L. Beersing, A. 2014. Configuring mine disturbed landforms for long-term sustainability. Proceedings of Mine Closure Solutions, 2014, April 26-30, 2014, Ouro Preto, Minas Gerais, Brazil.

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Stiller, D.M., Zimpfer, G.L., and Bishop, M. 1980. Application of geomorphic principles a surface mine reclamation in the semiarid West. Journal of Soil and Water Conservation, 274-277.

Toy, T.J., Hadley, R.F. 1987. *Geomorphology and Reclamation of Disturbed Lands*. Academic Press, London.

Toy, T.J., Black, J.P. 2000. Topographic reconstruction: the Theory and practice. In Reclamation of Drastically Disturbed Lands, Barnishel R et al. (eds). American Society of Agronomy: Madison; 41–75.

Toy, T.J., Chuse, W.R. 2005. Topographic reconstruction: a geomorphic approach. Ecological Engineering 24: 29-35.

Williams, G.P. 1986. River meanders and channel size. Journal of Hydrology, 88: 147-164.

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Zapico, I., Molina, A., Laronne, J., Sánchez, L., Martín Duque, J.F. 2020. Stabilization by geomorphic reclamation of a rotational landslide in an abandoned mine next to the Alto Tajo Natural Park. Engineering Geology, 264: 105321 https://doi.org/10.1016/j.enggeo.2019.105321.

Zapico, I., Laronne, J.B., Sánchez Castillo, L., Martín Duque, J.F. 2021. Drainage network evolution and reconstruction in an open pit kaolin mine at the edge of the Alto Tajo Natural Park. Catena, 204, 105392, pp. 1-12.

WEBSITES

Restauración Geomorfológica – www.restauraciongeomorfologica.es

LIFE RIBERMINE project - https://liferibermine.com/en/homepage_es/

Carlson software manuals - http://www.carlsonsw.com/support/manuals/.

Génie Géologique - http://www.2g.fr/.

GeoFluv - https://www.geofluv.com/

Landform Design Institute - https://landformdesign.com/

Landforma - https://www.landforma.com/

Mining Resource Consultancy - https://mresource.co.za/

SIBERIA – http://www.telluricresearch.com/siberia-homepage.html

Vast - https://vast-la.com/

VIDEO RESOURCES

LIFE RIBERMINE project - https://liferibermine.com/en/technical-gallery/ (highly recommended)

Geomorphic restoration of the Mangoola mine (Australia) – included at the beginning of video "Best practice rehabilitation being undertaken at Mangoola" **(highly recommended to be seen)** - https://www.glencore.com.au/operations-and-projects/coal/current-operations/mangoola-open-cut

Explanation of the GeoFluv method through the Natural Regrade software - https://www.youtube.com/watch?v=5VGRiA1IQ98

Geomorphic restoration at El Machorro mine - https://www.youtube.com/watch?v=Set5shHFYS8

Geomorphic restoration at the Nuria mine - https://www.youtube.com/watch?v=rYDQoGGd4l0

Geomorphic restoration at the Somolinos mine - https://www.youtube.com/watch?v=cLXiXzVvoXc