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PhD School - Politecnico di Milano

Regulations of the PhD Programme in

Science, Technology, and Policy for Sustainable Change (STEP-CHANGE)

Cycle XXXVIII

1. General Information

PhD School - Politecnico di Milano
PhD Programme: Science, Technology, and Policy for Sustainable Change (STEP-CHANGE)
Course start: November 2022
Location of the PhD Programme: Milano Leonardo
Promoter Department: Dipartimento di Elettronica, Informazione e Bioingegneria (DEIB)

Scientific Disciplinary Sectors

- BIO/07 Ecology
- ICAR/02 Hydraulic and marine constructions and hydrology
- ICAR/06 Topography and cartography
- ICAR/12 Architectural technology
- ICAR/13 Design
- ICAR/20 Urban and regional planning
- ING-IND/04 Aerospace structures and design
- ING-IND/09 Energy systems and power generation
- ING-IND/10 Thermal engineering and industrial energy systems
- ING-IND/11 Building physics and building energy systems
- ING-IND/15 Design methods for industrial engineering
- IND-IND/17 Industrial mechanical plants
- ING-IND/19 Nuclear power plants
- ING-IND/22 Materials science and technology
- ING-IND/23 Applied physical chemistry
- ING-IND/25 Chemical plants
- ING-IND/35 Business and management engineering
- ING-INF/04 Systems and control engineering
- ING-INF/05 Information processing systems
- M-FIL/02 Logic and Philosophy of Science
- SECS-P/02 Economic policy
- SPS/08 Sociology of culture and communication

PhD School website: http://www.polimi.it/phd
Ph.D. programme website: https://phd-step-change.polimi.it

2. General presentation

The PhD Programme in Science, Technology, and Policy for Sustainable Change (STEP-CHANGE) prepares the future generation of scientific experts for addressing the challenge of global change and steering society toward a sustainable and inclusive transition, including accelerating the penetration of green technologies, fostering industry decarbonisation, and designing sustainable policies from cross-sectoral perspectives. STEP-CHANGE offers a multicultural and trans-disciplinary research environment with strong connections to international research centres and private companies. Students will acquire research capacity and skills and in-depth knowledge about the complexity of Earth's natural and artificial systems; they will learn advanced methodologies to understand and model physical, industrial, societal, and digital processes impacting our planet ecosystem; and will develop projections of technological, ecological, and social trends to envision new sustainable solutions and systems, assessing their global environmental and societal impacts as well as related philosophical and ethical issues. Upon its successful completion and final exam, candidates will be awarded the title of PhD in Science, Technology, and Policy for Sustainable Change.

STEP-CHANGE stems from the cooperation of 11 departments:

- DEIB Department of Electronics, Information, and Bioengineering
- DENG Department of Energy
- DIG Department of Management, Economics, and Industrial Engineering
- DCMC Department of Chemistry, Materials, and Chemical Engineering "Giulio Natta"
- DICA Department of Civil and Environmental Engineering
- DABC Department of Architecture, Built Environment, and Construction Engineering
- DESIGN Department of Design
- DASTU Department of Architecture and Urban Studies
- DAER Department of Aerospace Science and Technology
- DMEC Department of Mechanical Engineering
- DMAT Department of Mathematics "Francesco Brioschi"

The programme lasts three years, is taught in English and is composed of three pillars:

- Basic Research, including methodological courses related to key aspects of theoretical and applied research in science, policy, and technology of sustainable change.

- Specific Research is designed to strengthen the PhD candidates' knowledge on specific topics aligned with their research interests and reinforce their presence in the international scientific community by participating in conferences and presenting scientific results to the academic community.

- Development of the Doctoral Thesis, involving the PhD candidate in the development of leading-edge research competencies and production of original scientific work contributing to the scientific debate and having societal impacts.

Research in the STEP-CHANGE PhD Programme focuses on developing novel methodologies and advancing applications on interdisciplinary cross-cutting topics, including planning and management of natural resources under change, global environmental change and socio-technical systems, industrial green transition pathways, multisector dynamics, impact assessment of technological changes, policy and decision-making processes, responsible research, ethics, and philosophy, artificial intelligence for global change, climate change techno-economic and financial risks, ecological and epidemiological

responses to global change, pro-environmental behaviour of citizens, institutions, and firms, digital carbon footprint, green IT, digital sustainability, design for sustainable product-service systems, sustainable products life cycle design.

Students are strongly encouraged to develop an international curriculum by participating in visiting periods, joint research, and international conferences or by spending at least one semester in a research institution or international organisation, taking advantage of the network of international collaborations of the 11 departments involved in the PhD Programme. This international exposure will be positively evaluated at the end of the PhD research.

A Coordinator and a Faculty Board run the PhD Programme. The Coordinator chairs the Faculty Board, coordinates the preparation of the annual Educational Programme, and organises educational activities of the PhD Programme (see Attachment A1). The Faculty Board is responsible for the Educational Programme as well as teaching and administrative activities related to the PhD Programme (see Attachment A2).

3. Objectives

The STEP-CHANGE PhD Programme aims to train the next generation of scientific experts to design feasible and effective pathways that can assure the planet's prosperity and preservation through state-of-the-art and novel scientific methods. At the end of the programme, PhD candidates are expected to possess the competencies and capacities required to support and inform the process of policy and strategy design for innovation-driven responses towards sustainable development.

4. Professional opportunities and job market

STEP-CHANGE graduates are equipped with unique skills and advanced trans-disciplinary knowledge that open up career possibilities as analysts, researchers, or planners at universities, international research centres, public and international institutions, R&D departments, regulatory authorities, policy institutions, and other public bodies.

5. Enrolment

5.1 Admission requirements

Italian and International citizens are eligible for admission to the PhD Programme. They must have graduated with a degree in accordance with the pre-existing laws D.M. 3.11.1999 n. 509, or to have a Master of Science degree in accordance with D.M. 3.11.1999 n. 509, or a Master of Science in accordance with D.M. 22.10.2004 n. 270, or a similar academic title obtained abroad equivalent in duration and content to the Italian title with an overall duration of university studies of at least five years. Certified knowledge of the English language is a requirement for admission. More details can be found on the PhD School website. Admission to the PhD Programme is evaluated based on the candidates' curricula, motivation letters, and an illustrative report about the development of a possible PhD research. Individual interviews will be carried out with shortlisted candidates.

5.2 Admission deadlines and positions available

The number of PhD positions is indicated in the Call for admission to the 38th PhD cycle Programmes (http://www.polimi.it/phd).

Each year, full scholarships are available for specific research topics as indicated in the call for admission. The financial support for oriented topics is provided by private companies, foundations, and research institutions. Limited support is also available for research periods abroad, to attend conferences, and to participate in extracurricular training activities.

6. Contents

6.1 Requirements for the PhD title achievement

The PhD title in Science, Technology, and Policy for Sustainable Change is granted upon achieving pre-established training and research goals. PhD candidates in STEP-CHANGE must earn a minimum of 20-course credits (see paragraph 6.3), continuously conduct studies and research, publish their scientific results in peer-reviewed journals, and submit their doctoral dissertation for approval by the Faculty Board and two external referees.

At the beginning of the programme, the PhD candidate is assigned a tutor who will supervise and assist the candidate over the entire training programme. The tutor shall be a professor belonging to the Faculty Board. The tutor shall assist the candidates in setting up their study plan. The study plan shall be submitted for approval to the PhD Programme coordinator (see also section 6.4). The Faculty Board may assign extra course credits to complete the candidate's preparation in specific topics relevant to their doctoral research.

6.2 Research development

The main aim of PhD Programmes at Politecnico di Milano is the development of a research-oriented mindset with expertise and skills in a specific research topic. To this end, candidates develop problem-solving capabilities in complex contexts, including the capacity for deep problem analysis, development of original solutions, and evaluation of practical applications. These skills provide PhD candidates with opportunities for developing their research both in the academic field and in public and private organisations.

PhD candidates shall develop original research contributions that substantially advance the state-of-the-art of science, technology, and policy for sustainable change. Their Research will be published in international peer-reviewed journals and conference proceedings. A final PhD dissertation will be prepared based on guidelines that will be provided by the Faculty Board.

The PhD candidate's research is developed under the guidance of a supervisor, who will support the candidate in developing a research plan and in the everyday activities related to its implementation. A co-supervisor can support the supervisor. The tutor and the supervisor must be from two different departments.

Additional activities to develop the candidate's skills and research expertise, such as participation in winter/summer schools, are encouraged during the PhD Programme. PhD candidates shall acquire the

capability to present and discuss their work in their research community. Consequently, participation in international workshops and conferences is highly encouraged.

The PhD programme favours candidates' research interactions with other groups in their research field, preferably abroad. An international research visit of at least six months is strongly encouraged and positively evaluated so that the candidates may acquire further skills to develop their research and dissertation.

The nominal duration of the PhD Programme is three years.

6.3 Objectives and learning activities

The PhD Programmes and the PhD School of Politecnico di Milano offer a variety of training opportunities to PhD candidates, including PhD courses, seminars, project workshops, and other activities. PhD courses cover research fundamentals (problems, theories, and methods), cross-disciplinary topics of interest across multiple PhD Programmes, and soft skill coaching. Additional training opportunities are offered through seminar cycles and workshops.

PhD Courses

The PhD School of Politecnico di Milano offers a catalogue of courses that train PhD candidates in soft and transferable skills. These courses prepare candidates to respond to the rapidly evolving needs of the global economy and society at large. Ten out of the twenty course credits shall be obtained through the courses offered by the PhD School (see Table A and B), preferably selecting one course per table.

The remaining ten credits shall be selected from the characterising courses of the PhD Programme (see Table C). These courses provide interdisciplinary knowledge on the science, technology, and policy for sustainable change as well as specialised methodological bases for specific topics relevant to the PhD candidate's doctoral research.

First/Second Year

The expected education path of the PhD candidate and associated credits are summarised below. The candidate's training activities must be completed by the end of the second year, with at least ten credits obtained by the end of the first year.

Course	Details or Reference	Number of credits
PhD School Courses	See Table A and B, and the School website	10
Courses characterising the PhD Programme	See Table C	10

Third year

The third year shall be devoted entirely to the research and development of the PhD candidate's dissertation.

Additional training opportunities

Additional training may be arranged in agreement with the supervisor and/or the tutor to acquire valuable expertise for developing doctoral research. This includes courses offered by the PhD School or the other PhD Programmes at Politecnico di Milano, courses offered by other Universities' PhD Programmes, summer/winter schools (e.g. IDEA LEAGUE), and seminar cycles. These additional training activities will not contribute to the required 20-course credits but will be considered in the annual evaluation of the candidate's performance. These courses and workshops shall be included in the study plan as "additional training activities".

Table A: SELECTION OF PHD COURSES OFFERED BY THE PHD SCHOOL[1] – GROUP A

Name of the Course	Professor	A.Y.	Credits
ETHICS IN RESEARCH	Aliverti Andrea, Hughes Jonathan	2022/23	5
SCIENTIFIC COMMUNICATION IN ENGLISH	Biscari Paolo, Sluckin Timothy Jan	2022/23	5
INTRODUCTION TO ACADEMIC RESEARCH	Volonte' Paolo	2022/23	5
RESEARCH SKILL	Sciuto Donatella	2022/23	5

Table B: SELECTION OF PHD COURSES OFFERED BY THE PHD SCHOOL – GROUP B

Name of the Course	Professor	A.Y.	Credits
CREATIVE DESIGN THINKING	Canina Maria Rita	2022/23	5
HOW TO SUPPORT COMPLEX DECISIONS: APPROACHES AND TOOLS	Oppio Alessandra, Dell'Ovo Marta	2022/23	5
APPROACHES TO RESILIENCE: SOCIAL, ECONOMIC, ENVIRONMENTAL AND TECHNOLOGICAL CHALLENGES OF CONTEMPORARY HUMAN SETTLEMENTS	Balducci Alessandro - multiple instructors	2022/23	5
SUSTAINABILITY METRICS, LIFE CYCLE ASSESSMENT AND ENVIRONMENTAL FOOTPRINT	Lavagna Monica- multiple instructors	2022/23	5
THE COPERNICUS GREEN REVOLUTION FOR SUSTAINABLE DEVELOPMENT	Gianinetto Marco - multiple instructors	2022/23	5

[1] The full list is available here https://www.dottorato.polimi.it/en/phd-school/phd-level-courses

Table C: PHD COURSES CHARACTERISING THE PHD PROGRAMME

SSD	Name of the Course	Professor	A.Y.	PhD Programme	Credits
ING/INF04	PERSPECTIVES IN SCIENCE, TECHNOLOGY, AND POLICY OF SUSTAINABLE CHANGE	Castelletti Andrea - multiple instructors	2022/23	STEP-CHANGE	5
ING/INF04	DATA-DRIVEN APPROACHES TO UNCERTAIN OPTIMIZATION AND DECISION-MAKING: THEORY AND APPLICATIONS	Garatti Simone	2022/23	IT	5
ING/INF05	ADVANCED TOPICS IN DEEP LEARNING: THE RISE OF TRANSFORMERS	Matteucci Matteo	2022/23	IT	5
ING/INF05	PARALLEL COMPUTING ON TRADITIONAL CORE-BASED AND EMERGING GPU-BASED ARCHITECTURES THROUGH OPENMP AND OPENACC / CUDA	Breveglieri Luca	2022/23	IT	5
ING/INF05	INTERPRETABILITY AND EXPLAINABILITY IN MACHINE LEARNING	Loiacono Daniele	2022/23	DADS	5
ING/IND35	ANALYTICS FOR SOCIETY	Fiori Andrea	2022/23	DADS	5
ING/IND04	THE ADVANCED AIR MOBILITY REVOLUTION	Giuseppe Quaranta - multiple instructors	2022/23	DAER	5
SECS-P/05	ADVANCED TOPICS IN ECONOMETRICS	Mosconi Rocco	2022/23	DIG	5
ING/IND35	SURVEY AND EXPERIMENTAL RESEARCH METHODOLOGIES	Caniato Federico – multiple instructors	2022/23	DIG	5

6.4 Presentation of the study plan

PhD candidates must submit the study plan for approval to the PhD Programme Coordinator following procedures established by the Faculty Board. The study plan may be revised periodically (approximately every three months) to adapt to possible changes in the course offerings or other needs related to the PhD candidate's career development.

6.5 Yearly evaluations

At the end of each year, the PhD candidate's progress is evaluated by the Faculty Board, which decides on the candidate's admission to the following PhD year. Evaluation in the third year establishes the candidate's admission to the final PhD defence.

Positively evaluated candidates may proceed with enrolment to the following year. Candidates with a negative assessment are qualified either as "Repeating candidate" or "not able to carry on with the PhD". In the former case, candidates are allowed to repeat the PhD year at most once, and the PhD scholarship (if any) is suspended until completion of the repetition year. In the latter case, candidates are excluded from the PhD Programme and forfeit their scholarship. If the Faculty Board holds appropriate to assign an exclusion evaluation without the opportunity for a repetition year, such assessment must be validated by the PhD School and adequately motivated.

After the third year, candidates who have achieved satisfactory results but need more time to complete their dissertation may obtain a prorogation for up to 1 additional year.

6.6 PhD dissertation preparation

The main objective of the PhD career is the development of an original research contribution. The doctoral dissertation is expected to advance knowledge in the candidate's research field.

The PhD study and research work are expected to be carried out full time during the PhD Programme. Stages or study periods in (Italian or International) companies or external Institutions may complete the candidate's preparation.

The doctoral dissertation must be concordant with interdisciplinary cross-cutting research topics of STEP-CHANGE (see 2).

The candidate must present an original dissertation, discuss its innovation with respect to the state-of-the-art, and its relevance to sustainable change and policy-making. The dissertation shall also include an executive summary in the form of a policy brief.

At the conclusion of the PhD candidate's studies, the Faculty Board performs a final evaluation of the candidate. Candidates who receive a positive evaluation will submit their dissertation to two external referees. If the evaluation provided by the external referees is positive (or after the candidate completes any revisions required by the external reviewers), candidates will defend their dissertation in a final exam in front of a committee composed of at least three members, at least two of which must be external experts in the candidate's field of research.

7. PhD Secretary Services

The secretary service of the PhD Programme can be reached at phd-step-change@polimi.it

8. Internationalisation and interdisciplinarity

Carrying out study and research activities in international Universities and Research Centres is strongly recommended. Politecnico di Milano supports joint PhD paths with International Institutions, as well as Joint and Double PhD programmes. Further information is available on the PhD School website and on the PhD Programme website.

Attachment A1 – PhD Programme Coordinator

SHORT BIO

Andrea Castelletti is a full professor of Natural Resources Management and Environmental Systems Analysis and Management at Politecnico di Milano, Italy and a senior scientist at the Department of Civil and Environmental Engineering, ETH Zurich, Switzerland. He received a MSc degree in Environmental Engineering and a PhD in Information Engineering from Politecnico di Milano in 1999 and 2005. He was visiting scholar at Cornell University, Lancaster University, and University of Western Australia. From 2007 to 2015 he was Adjunct Professor at the Centre for Water Research of the University of Western Australia. He is the head of the Environmental Intelligence Lab at Politecnico di Milano and Chair of the PhD Programme in Science, Technology, and Policy for Sustainable Change.

Dr. Castelletti research interest includes water systems planning and control under uncertainty and risk, decision- making for complex engineering systems, big environmental data analytics and smart sensing, information theory and selection for environmental decision making. He has been working for more than 15 years on Vietnamese water resources systems. (Red River and Mekong), exploring novel approach to sustainable and robust design and operation of water infrastructure. He has been and is currently involved in many international and national projects including several EU H2020 projects.

Dr. Castelletti is co-author of 2 international books on integrated water resource management, more than 200 publications in international journals, book chapters and conference proceedings. In 2021 his work on strategic planning of the Mekong hydropower expansion has been awarded the ASPEN Institute award from best Italy-US research. In 2009 he was awarded a senior fellowship by the Japanese Society for the Promotion of Science, in 2010 an Early Career Excellence Award by the International Environmental Modelling and Software Society, in 2013 the Italy-Canada Innovation prize, in 2016 the EFARRI award, and in 2018 he was Biennial Medalist for the International Environmental Modelling and Software Society. Dr. Castelletti serves the scientific community as the chair of the EGU Program Committees on Water policy, management and operation and member of the ASCE/EWRI Environmental and Water Resources Systems Technical Committee (since 2011). He is the past chair and current deputy chair of the IFAC Technical Committee TC8.3 on Modelling and Control of Environmental Systems (2008-2014). He is Associate Editor of Water Resources Research, Journal of Hydrology, Environmental Modelling and Software, and the Socio-Ecological Systems Modelling. More information on http://www.ei.deib.polimi.it/.

SELECTED PUBLICATIONS

1. Giuliani,M., J.R.Lamontagne, M.Heiazi, P.M.Reed, and **A.Castelletti**,The unintended consequences of climate mitigation for African river basins, *Nature Climate Change*, 12(2), 187-192, 2022.
2. Schmitt, R.J.P. , M. Giuliani, S. Bizzi, G.M. Kondolf, G.C. Daily, and **A. Castelletti**, Strategic basin and delta planning increases the resilience of the Mekong Delta under future uncertainty, *Proceedings of the National Academy of Sciences*, 118 (36) e2026127118, 2021.
3. M. Zaniolo, M. Giuliani, S. Sinclair, P. Burlando, and **A. Castelletti**, When timing matters—misdesigned dam filling impacts hydropower sustainability, *Nature Communications*, 12, 3056, 2021.
4. B. Belletti, C. Garcia de Leaniz, J. Jones, S. Bizzi, L. Borger, G. Segura, **A. Castelletti**, et al., More than one million barriers fragment Europe's rivers, *Nature*, 588, 436-444, 2020.
5. R.J. Schmitt, S. Bizzi, **A. Castelletti**, J.J. Opperman, G.M Kondolf, Planning dam portfolios for low sediment trapping shows limits for sustainable hydropower in the Mekong, *Science Advances*, 5(10) eaaw2175, 2019.

Attachment A2 - PhD Faculty Board

Description of the composition of the Faculty Board

NAME	AFFILIATION	SCIENTIFIC DISCIPLINARY SECTOR
Aste Niccolò	DABC	ING-IND/11
Baraldi Piero	DENG	ING-IND/19
Biagi Ludovico Giorgio Aldo	DICA	ICAR/06
Biscari Paolo	DFIS	FIS/03
Cagno Enrico	DIG	ING-IND/17
Campioli Andrea	DABC	ICAR/12
Capelli Laura Maria Teresa	DCMC	ING-IND/23
Casagrandi Renato	DEIB	BIO/07
Cascini Gaetano	DMEC	ING-IND/15
Castelletti Andrea	DEIB	ING-INF/04
Colombo Emanuela	DENG	ING-IND/10
Fraternali Piero	DEIB	ING-INF/05
Giuliani Matteo	DEIB	ING-INF/04
Lorenzi Stefano	DENG	ING-IND/19
Manzolini Giampaolo	DENG	ING-IND/09
Pastore Maria Chiara	DASTU	ICAR/21
Pernici Barbara	DEIB	ING-INF/05
Quaranta Giuseppe	DAER	ING-IND/04
Rizzo Francesca	DESIGN	ICAR/13
Rocco Matteo	DENG	ING-IND/10
Rossi Filippo	DCMC	ING-IND/23
Rulli Maria Cristina	DICA	ICAR/02
Schiaffonati Viola	DEIB	M-FIL/02
Tajoli Lucia	DIG	SECS-P/02
Tavoni Massimo	DIG	ING-IND/35
Valente Giovanni	DMAT	M-FIL/02
Vicenzo Antonello	DCMC	ING-IND/22
Volontè Paolo	DESIGN	SPS/08