TABLE OF CONTENTS

systems.

in dam risk management.

ABST	RACT	. 3	
RESU	MEN	. 4	
RESUM5			
ACKNOWLEDGEMENTS7			
TABLE OF CONTENTS9			
ACRONYMS11			
LIST OF FIGURES1			
LIST	OF TABLES	12	
1. I	NTRODUCTION	13	
1.1	. Topic and focus	13	
1.2	. Research motivation	14	
1.3	. Objectives	17	
2. F	PUBLICATIONS	19	
3. F	RESULTS AND DISCUSSION2	21	
3.1	. Introduction2	21	
3.2 fai	. Part I: Methodology to integrate pluvial flooding, river flooding and da		
3.3 ass	. Part II: Methodology to incorporate fluvial dikes (levees) into flood ri		
3.4 ris	Part III: Screening procedure to incorporate malevolent threats into dak analysis and flood risk assessment		
3.5	. Towards smart risk governance for flood risk reduction	56	
4. (CONCLUSIONS	59	
4.1	. Summary of research outcomes	59	
4.2	. Implications and final remarks6	50	
4.3	. Future research lines: the way ahead ϵ	51	
5. F	REFERENCES6	53	
ANN	EXES6	57	
•	Annex 1. The value of integrating information from multiple hazards f flood risk analysis and management.	or	
•	Annex 2. Enhancing local action planning through quantitative flood rianalysis: a case study in Spain.	sk	

• Annex 3. A combined risk analysis approach for complex dam-levee

• **Annex 4.** Screening procedure for analysing the impact of manmade threats

- **Annex 5.** Towards an integrated flood risk management in urban areas: pluvial and river flooding including structural collapse.
- **Annex 6.** A risk-informed journey towards improved dam safety governance in Spain.

ACRONYMS

ACSLS Adjusted Cost per Statistical Life Saved ANCOLD Australian National Committee on Large Dams United States Department of Homeland Security DHS **Emergency Action Plan EAP** Flood Risk Management **FRM** Research Institute of Water and Environmental Engineering IIAMA International Risk Governance Council **IRGC** Spanish Ministry of Agriculture, Food and Environment MAGRAMA Normal Operating Level NOL Quantitative Risk Analysis QRA Spanish National Committee on Large Dams **SPANCOLD** Universitat Politècnica de València UPV **USACE United States Army Corps of Engineers**

LIST OF FIGURES

Figure 1. Phases of the methodology and additional contributions to key stages26
Figure 2. Generic influence diagram: Independent initiating event (Scheme A1)27
Figure 3. Generic influence diagram: Independent initiating event (Scheme A2)28
Figure 4. Generic influence diagram: Common initiating event (Scheme B)28
Figure 5. Combination of outcomes of different risk models30
Figure 6. Flowchart of data and models for flood risk analysis32
Figure 7. Influence diagram representing Risk model A for case study 133
Figure 8. Influence diagram representing Risk model B for case study 134
Figure 9. Results for three scenarios for case study 1: current situation (Base Case),
after dam construction (DEAP-case) and after implementing non-structural
measures (NonSt Case). Note: FN graph for the Base Case in Annex 1 shows results
only from river flooding35
Figure 10. Risk model architecture for the case study 2
Figure 11. FN and FD curves obtained for case study 239
Figure 12. Example of risk map for case study 2. It can be downloaded from this
link39
Figure 13. Generic combined dam-levee risk model scheme41
Figure 14. Scheme of case study 343
Figure 15. Risk model architecture scheme for case study 3: dam risk model
(incremental risk)44
Figure 16. Risk model architecture scheme for case study 3: dam risk model (total
risk)45
Figure 17. Risk model architecture scheme for case study 3: levee risk model45
Figure 18. Risk model architecture scheme for case study 3: combined dam-levee
system risk model46
Figure 19. fN pairs from dam and levee risk models47
Figure 20. FN curves from dam risk model vs. combined dam-levee risk model48
Figure 21. Screening procedure for analyzing the impact of manmade threats in
dam risk analysis50
Figure 22. fN graph obtained for case study 4: (a) safety and (b) security risk
outcomes55

Figure 23. Connections among science, policy and society for efficient flood risk management (Porta-Sancho et al., 2016)		
LIST OF TABLES		
Table 1. Objectives and PhD thesis outcomes20		
Table 2. Societal and economic risk results for case study 135		
Table 3. Societal and economic risk results for case study 238		
Table 4. ACSLS results for analysed measures in case study 240		
Table 5. Risk outcomes for case study 3: dam risk model		
Table 6. Risk outcomes for case study 3: levee risk models47		
Table 7. Risk outcomes for case study 3: combined system risk model47		
Table 8. Steps of the screening procedure for analyzing the impact of manmade		
threats in dam risk management51		
Table 9. Risk outcomes for case study 453		