Supplementary Materials

Table S1. Categorisation of reviewed papers by assessment objects.

Assessment Objects	Assessment Sub-Objects	Publications	Total Number
Earthquakes	Tectonic Earthquakes	[1-54]	54
	Man-Made Earthquakes	[55-59]	5
Earthquake-Induced Secondary Disasters	Landslide	[10, 60-88]	30
	Tsunami	[75, 89-93]	6
Buildings Affected by Earthquakes	Buildings	[89, 94-135]	43
	Building structures or components	[136-166]	31
Infrastructure Affected by Earthquakes	—	[102, 137, 145, 151, 154, 162, 164, 167-180]	21
Regions Affected by Earthquakes	—	[181-189]	9

Table S2. Categorisation of reviewed papers by data types.

Data Types	Data Sub-Types		Publications	Total Number
Remote Sensing Data	Satellite Data	Optical Satellite Data	[2, 62, 65-67, 74, 84, 85, 88, 93, 124, 130, 187]	13
		SAR Data	[35, 62, 63, 67, 73, 89, 90, 93, 183]	9
		InSAR Data	[40, 63]	2
		Other Satellite Data	[10, 21, 24, 25, 42, 45, 60, 61, 68, 70, 75, 77, 79-83, 86, 87, 91, 94, 97, 98, 104, 106, 107, 110-113, 121-123, 125, 141, 149, 155, 157, 167, 178, 179, 181, 185, 189]	44
	Aerial Images		[64, 71, 76, 82, 83, 101, 103-105, 108, 109, 112, 115, 117, 119, 126, 133, 135, 143, 149, 152, 154, 155, 157, 171, 179, 180, 188]	28
	Point Cloud Data		[9, 58, 99, 131]	4
Seismic Data	Ground Motion Data		[12, 13, 17-19, 23, 24, 31, 33, 34, 46, 69, 96, 113, 114, 127, 128, 134, 136-138, 140, 142, 144, 145, 148, 156, 159-161, 163, 164, 166, 168-170, 172, 173, 175-177, 182-184, 186]	45
	Earthquake Catalogues		[8, 20, 22-28, 39, 52]	11
	Seismic Signal		[7, 11, 14, 16, 27-30, 32, 36-38, 41, 43, 44, 50-59, 150, 158]	27
Social Media Data	-		[3, 4, 6, 15, 47-49, 95, 118]	9

Others	-	[1, 5, 92, 100, 102, 116, 120, 129, 132, 146, 147, 151, 153, 165, 174]	15

Table S3. Categorisation of reviewed papers by assessment models.

Models	Sub-Model	Publications	Total Number
Convolutional Neural Network (CNN)	1D CNN 2D CNN 3D CNN	[5, 7, 11, 16, 19, 22, 24, 25, 40, 41, 44, 49, 50, 54, 56-58, 61, 65-68, 72, 76, 82, 84, 87, 92, 96, 100, 101, 104-106, 108, 112, 113, 119, 122, 127, 128, 132, 136, 137, 140, 143, 145, 149, 154, 159, 160, 164, 166, 170, 178, 186, 187]	57
	DCNN	[27, 29, 55, 56, 99, 114, 120, 121, 137, 139, 144, 146, 153, 158, 160, 181, 183]	17
	Fully Convolutional Network (FCN, including U-Net)	[28, 32, 33, 52, 73, 80, 83, 86, 89, 91, 162, 171]	12
	VGGNet	[3, 94, 97, 99, 107, 115, 123, 151, 153, 157, 188]	11
	Inception (GoogLeNet)	[56, 97, 99, 102, 107, 117, 123, 151, 157]	9
	ResNet	[83, 85, 90, 97, 99, 107, 123, 151, 157]	9
	You Look Once Time (YOLO)	[3, 35, 63, 74, 116, 126, 130, 165]	8
	Mask R-CNN	[2, 64, 71, 81, 129, 133]	6
	DenseNet	[97, 134, 157, 166]	4
	Faster R-CNN	[103, 141, 147]	3
	Xception	[107, 123, 151]	3
	SqueezeNet	[90, 111]	2
	MobileNet	[97, 151]	2
	DeepLab	[80, 135]	2
	AlexNet	[38, 90]	2
	PSPNet	[98]	1
	PointNet	[131]	1
	R-CNN	[180]	1
	Single Shot MultiBox Detector (SSD)	[189]	1
	Other improved models of CNN	[1, 14, 28-30, 36, 37, 47, 48, 51, 53, 75, 109, 124, 125, 148, 152, 156, 161, 163]	20
Multi-Layer Perceptron (MLP)	Deep Neural Network (DNN)	[9, 13, 18, 31, 42, 44, 45, 68, 88, 168, 173, 184]	12
	Multi-layer Perceptron (MLP)	[6, 20, 43, 69, 84, 137]	6
Transfer Learning (TL)	-	[3, 64, 80, 83, 99, 100, 110, 115, 121, 137, 144, 149, 151, 189]	14
Recurrent Neural Network (RNN)	Long Short-Term Memory (LSTM)	[15, 21, 30, 39, 43, 59, 68, 69, 118, 134, 137, 150, 172]	13
	Recurrent Neural Network (RNN)	[17, 23, 41, 68, 69, 138, 158]	7

	Gated Recurrent Unit (GRU)	[15, 69]	2
Generative Adversarial Network (GAN)	-	[12, 13, 34, 155, 166]	5
Autoencoder	-	[40, 53, 70, 93, 182]	5
Feedforward Neural Network (FNN)	-	[160, 164, 169, 175]	4
Deep Belief Network (DBN)	-	[77, 79]	2
Other deep learning models	-	[8, 10, 26, 60, 62, 66, 78, 95, 114, 160, 172, 174, 176, 177, 179, 185, 187]	17
Hybrid Models (Deep learning combined with other models)	-	[3, 8, 21, 24-26, 43-45, 55, 61, 65, 66, 70, 72, 78, 79, 82-84, 87, 95, 112, 113, 117, 130, 138, 145, 159, 163, 187]	31

Table S4. Categorisation of reviewed papers by assessment stages.

Assessment Stages	**Assessment Sub-Stages**	**Publications**	**Total Number**
Pre-Earthquake Stage	Earthquake Prediction	[5, 7, 8, 12, 13, 16-20, 22, 23, 28, 30-32, 34, 39, 43, 46, 50, 54, 114, 163, 168, 172, 182]	27
	Risk Assessment	[2, 21, 24, 25, 45, 94, 97, 99, 102, 106, 107, 121, 123, 129, 150, 161, 169, 173, 175, 177, 180, 183, 187]	23
During-earthquake Stage	Damage Detection	[96, 98, 103, 111, 116, 117, 119, 120, 124, 126, 132, 136-141, 144, 147-149, 152-155, 157, 158, 162, 165-167, 170, 171, 174, 181, 185]	36
	Disaster Situation Analysis	[1, 3, 4, 6, 11, 15, 35, 47-49, 51, 55, 134, 178]	14
	Earthquake Localisation	[27, 29, 33, 36, 38, 40, 41, 52, 56-58]	11
	Seismic Data Processing	[14, 37, 44, 53, 59]	5
	Secondary Disaster Assessment	[10, 60-84, 86-88, 90-93]	33

Post-Earthquake Stage	Loss Assessment	[9, 26, 42, 95, 100, 101, 104, 108-110, 113, 115, 122, 133, 135, 145, 146, 151, 156, 159, 160, 164, 176, 186, 188]	25
	Safety Assessment	[85, 118, 127, 128, 142, 179, 189]	7
Multi-Stage	-	[89, 105, 112, 125, 130, 131, 143, 184]	8

References

1. Aamir, Muhammad, Tariq Ali, Muhammad Irfan, Ahmad Shaf, Muhammad Zeeshan Azam, Adam Glowacz, Frantisek Brumercik, Witold Glowacz, Samar Alqhtani, and Saifur Rahman. "Natural Disasters Intensity Analysis and Classification Based on Multispectral Images Using Multi-Layered Deep Convolutional Neural Network." *SENSORS* 21, no. 8 (2021). https://doi.org/10.3390/s21082648.
2. An, Liqiang, and Jingfa Zhang. "Impact of Urbanization on Seismic Risk: A Study Based on Remote Sensing Data." *SUSTAINABILITY* 14, no. 10 (2022). https://doi.org/10.3390/su14106132.
3. Asif, Amna, Shaheen Khatoon, Md Maruf Hasan, Majed A. Alshamari, Sherif Abdou, Khaled Mostafa Elsayed, and Mohsen Rashwan. "Automatic Analysis of Social Media Images to Identify Disaster Type and Infer Appropriate Emergency Response." *JOURNAL OF BIG DATA* 8, no. 1 (2021). https://doi.org/10.1186/s40537-021-00471-5.
4. Bai, Hua, Hualong Yu, Guang Yu, Alvaro Rocha, and Xing Huang. "Analysis on an Auto Increment Detection System of Chinese Disaster Weibo Text." *JOURNAL OF UNIVERSAL COMPUTER SCIENCE* 27, no. 2 (2020): 230-52. https://doi.org/10.3897/jucs.65106.
5. Bao, Zhenyu, Jingyu Zhao, Pu Huang, Shanshan Yong, and Xin'an Wang. "A Deep Learning-Based Electromagnetic Signal for Earthquake Magnitude Prediction." *SENSORS* 21, no. 13 (2021). https://doi.org/10.3390/s21134434.
6. Behl, Shivam, Aman Rao, Sahil Aggarwal, Sakshi Chadha, and H. S. Pannu. "Twitter for Disaster Relief through Sentiment Analysis for Covid-19 and Natural Hazard Crises." *INTERNATIONAL JOURNAL OF DISASTER RISK REDUCTION* 55 (2021). https://doi.org/10.1016/j.ijdrr.2021.102101.
7. Bilal, Muhammad Atif, Yanju Ji, Yongzhi Wang, Muhammad Pervez Akhter, and Muhammad Yaqub. "Early Earthquake Detection Using Batch Normalization Graph Convolutional Neural Network (Bngcnn)." *APPLIED SCIENCES-BASEL* 12, no. 15 (2022). https://doi.org/10.3390/app12157548.
8. Chelidze, Tamaz, Giorgi Melikadze, Tengiz Kiria, Tamar Jimsheladze, and Gennady Kobzev. "Statistical and Non-Linear Dynamics Methods of Earthquake Forecast: Application in the Caucasus." *FRONTIERS IN EARTH SCIENCE* 8 (2020). https://doi.org/10.3389/feart.2020.00194.
9. Chen, Jingdao, and Yong Kwon Cho. "Crackembed: Point Feature Embedding for Crack Segmentation from Disaster Site Point Clouds with Anomaly Detection." *ADVANCED ENGINEERING INFORMATICS* 52 (2022). https://doi.org/10.1016/j.aei.2022.101550.
10. Chowdhuri, Indrajit, Subodh Chandra Pal, Asish Saha, Rabin Chakrabortty, and Paramita Roy. "Mapping of Earthquake Hotspot and Coldspot Zones for Identifying Potential Landslide Hotspot Areas in the Himalayan Region." *BULLETIN OF ENGINEERING GEOLOGY AND THE ENVIRONMENT* 81, no. 7 (2022). https://doi.org/10.1007/s10064-022-02761-5.
11. Di, Haibin, Zhun Li, and Aria Abubakar. "Using Relative Geologic Time to Constrain Convolutional Neural Network-Based Seismic Interpretation and Property Estimation." *GEOPHYSICS* 87, no. 2 (2022): IM25-IM35. https://doi.org/10.1190/GEO2021-0257.1.
12. Ding, Yinjun, Jun Chen, and Jiaxu Shen. "Conditional Generative Adversarial Network Model for Simulating Intensity Measures of Aftershocks." *SOIL DYNAMICS AND EARTHQUAKE ENGINEERING* 139 (2020). https://doi.org/10.1016/j.soildyn.2020.106281.

13. ———. "Prediction of Spectral Accelerations of Aftershock Ground Motion with Deep Learning Method." *SOIL DYNAMICS AND EARTHQUAKE ENGINEERING* 150 (2021). https://doi.org/10.1016/j.soildyn.2021.106951.
14. Dong, Xintong, Jun Lin, Shaoping Lu, Hongzhou Wang, and Yue Li. "Multiscale Spatial Attention Network for Seismic Data Denoising." *IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING* 60 (2022). https://doi.org/10.1109/TGRS.2022.3178212.
15. Eliguzel, Nazmiye, Cihan Cetinkaya, and Turkay Dereli. "Application of Named Entity Recognition on Tweets During Earthquake Disaster: A Deep Learning-Based Approach." *SOFT COMPUTING* 26, no. 1 (2022): 395-421. https://doi.org/10.1007/s00500-021-06370-4.
16. Ertuncay, Deniz, Andrea De Lorenzo, and Giovanni Costa. "Identification of near-Fault Impulsive Signals and Their Initiation and Termination Positions with Convolutional Neural Networks." *GEOSCIENCES* 11, no. 9 (2021). https://doi.org/10.3390/geosciences11090388.
17. Fayaz, Jawad, and Carmine Galasso. "A Generalized Ground-Motion Model for Consistent Mainshock-Aftershock Intensity Measures Using Successive Recurrent Neural Networks." *BULLETIN OF EARTHQUAKE ENGINEERING* 20, no. 12 (2022): 6467-86. https://doi.org/10.1007/s10518-022-01432-w.
18. ———. "A Deep Neural Network Framework for Real-Time on-Site Estimation of Acceleration Response Spectra of Seismic Ground Motions." *COMPUTER-AIDED CIVIL AND INFRASTRUCTURE ENGINEERING* 38, no. 1 (2023): 87-103. https://doi.org/10.1111/mice.12830.
19. Hong, Seokgyeong, Nguyen Huyen-Tram, Jongwon Jung, and Jaehun Ahn. "Seismic Ground Response Estimation Based on Convolutional Neural Networks (Cnn)." *APPLIED SCIENCES-BASEL* 11, no. 22 (2021). https://doi.org/10.3390/app112210760.
20. Jain, Rachna, Anand Nayyar, Simrann Arora, and Akash Gupta. "A Comprehensive Analysis and Prediction of Earthquake Magnitude Based on Position and Depth Parameters Using Machine and Deep Learning Models." *MULTIMEDIA TOOLS AND APPLICATIONS* 80, no. 18 (2021): 28419-38. https://doi.org/10.1007/s11042-021-11001-z.
21. Jena, Ratiranjan, Sambit Prasanajit Naik, Biswajeet Pradhan, Ghassan Beydoun, Hyuck-Jin Park, and Abdullah Alamri. "Earthquake Vulnerability Assessment for the Indian Subcontinent Using the Long Short-Term Memory Model (Lstm)." *INTERNATIONAL JOURNAL OF DISASTER RISK REDUCTION* 66 (2021). https://doi.org/10.1016/j.ijdrr.2021.102642.
22. Jena, Ratiranjan, Biswajeet Pradhan, Abdullah Al-Amri, Chang Wook Lee, and Hyuck-jin Park. "Earthquake Probability Assessment for the Indian Subcontinent Using Deep Learning." *SENSORS* 20, no. 16 (2020). https://doi.org/10.3390/s20164369.
23. Jena, Ratiranjan, Biswajeet Pradhan, and Abdullah M. Alamri. "Susceptibility to Seismic Amplification and Earthquake Probability Estimation Using Recurrent Neural Network (Rnn) Model in Odisha, India." *APPLIED SCIENCES-BASEL* 10, no. 15 (2020). https://doi.org/10.3390/app10155355.
24. Jena, Ratiranjan, Biswajeet Pradhan, Ghassan Beydoun, Abdullah M. Alamri, Ardiansyah, Nizamuddin, and Hizir Sofyan. "Earthquake Hazard and Risk Assessment Using Machine Learning Approaches at Palu, Indonesia." *SCIENCE OF THE TOTAL ENVIRONMENT* 749 (2020). https://doi.org/10.1016/j.scitotenv.2020.141582.
25. Jena, Ratiranjan, Biswajeet Pradhan, Sambit Prasanajit Naik, and Abdullah M. Alamri. "Earthquake Risk Assessment in Ne India Using Deep Learning and Geospatial Analysis." *GEOSCIENCE FRONTIERS* 12, no. 3 (2021). https://doi.org/10.1016/j.gsf.2020.11.007.
26. Jia, Hanxi, Junqi Lin, and Jinlong Liu. "An Earthquake Fatalities Assessment Method Based on Feature Importance with Deep Learning and Random Forest Models." *SUSTAINABILITY* 11, no. 10 (2019). https://doi.org/10.3390/su11102727.

27. Kriegerowski, Marius, Gesa M. Petersen, Hannes Vasyura-Bathke, and Matthias Ohrnberger. "A Deep Convolutional Neural Network for Localization of Clustered Earthquakes Based on Multistation Full Waveforms." *SEISMOLOGICAL RESEARCH LETTERS* 90, no. 2 (2019): 510-16. https://doi.org/10.1785/0220180320.
28. Kuang, Wenhuan, Congcong Yuan, and Jie Zhang. "Network-Based Earthquake Magnitude Determination Via Deep Learning." *SEISMOLOGICAL RESEARCH LETTERS* 92, no. 4 (2021): 2245-54. https://doi.org/10.1785/0220200317.
29. ———. "Real-Time Determination of Earthquake Focal Mechanism Via Deep Learning." *NATURE COMMUNICATIONS* 12, no. 1 (2021). https://doi.org/10.1038/s41467-021-21670-x.
30. Laurenti, Laura, Elisa Tinti, Fabio Galasso, Luca Franco, and Chris Marone. "Deep Learning for Laboratory Earthquake Prediction and Autoregressive Forecasting of Fault Zone Stress." *EARTH AND PLANETARY SCIENCE LETTERS* 598 (2022). https://doi.org/10.1016/j.epsl.2022.117825.
31. Li, Chenxi, Duofa Ji, Changhai Zhai, Yuhong Ma, and Lili Xie. "Vertical Ground Motion Model for the Nga-West2 Database Using Deep Learning Method." *SOIL DYNAMICS AND EARTHQUAKE ENGINEERING* 165 (2023). https://doi.org/10.1016/j.soildyn.2022.107713.
32. Liao, Wu-Yu, En-Jui Lee, Dawei Mu, and Po Chen. "Toward Fully Autonomous Seismic Networks: Backprojecting Deep Learning-Based Phase Time Functions for Earthquake Monitoring on Continuous Recordings." *SEISMOLOGICAL RESEARCH LETTERS* 93, no. 3 (2022): 1880-94. https://doi.org/10.1785/0220210274.
33. Lilienkamp, Henning, Sebastian von Specht, Graeme Weatherill, Giuseppe Caire, and Fabrice Cotton. "Ground-Motion Modeling as an Image Processing Task: Introducing a Neural Network Based, Fully Data-Driven, and Nonergodic." *BULLETIN OF THE SEISMOLOGICAL SOCIETY OF AMERICA* 112, no. 3 (2022): 1565-82. https://doi.org/10.1785/0120220008.
34. Matinfar, Mehrshad, Naser Khaji, and Goodarz Ahmadi. "Deep Convolutional Generative Adversarial Networks for the Generation of Numerous Artificial Spectrum-Compatible Earthquake Accelerograms Using a Limited Number of Ground Motion Records." *COMPUTER-AIDED CIVIL AND INFRASTRUCTURE ENGINEERING* 38, no. 2 (2023): 225-40. https://doi.org/10.1111/mice.12852.
35. Morisaki, Yuma, Makoto Fujiu, Taiki Suwa, Ryoichi Furuta, and Junichi Takayama. "Detection of Location from Kits Set up by Vulnerable People During Earthquake Disasters with Communication Blackout: Study Using Yolov5 Algorithm." *SUSTAINABILITY* 14, no. 21 (2022). https://doi.org/10.3390/su142113895.
36. Perol, Thibaut, Michael Gharbi, and Marine Denolle. "Convolutional Neural Network for Earthquake Detection and Location." *SCIENCE ADVANCES* 4, no. 2 (2018). https://doi.org/10.1126/sciadv.1700578.
37. Qian, Feng, Zhangbo Liu, Yan Wang, Yingjie Zhou, and Guangmin Hu. "Ground Truth-Free 3-D Seismic Random Noise Attenuation Via Deep Tensor Convolutional Neural Networks in the Time-Frequency Domain." *IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING* 60 (2022). https://doi.org/10.1109/TGRS.2022.3149545.
38. Ren, Jiaqi, Shaohui Zhou, Jianyong Wang, Shun Yang, and Chao Liu. "Research on Identification of Natural and Unnatural Earthquake Events Based on Alexnet Convolutional Neural Network." *WIRELESS COMMUNICATIONS & MOBILE COMPUTING* 2022 (2022). https://doi.org/10.1155/2022/6782094.
39. Sadhukhan, Bikash, Shayak Chakraborty, and Somenath Mukherjee. "Predicting the Magnitude of an Impending Earthquake Using Deep Learning Techniques." *EARTH SCIENCE INFORMATICS* (2022). https://doi.org/10.1007/s12145-022-00916-2.
40. Shakeel, Anza, Richard J. Walters, Susanna K. Ebmeier, and Noura Al Moubayed. "Aladdin: Autoencoder-Lstm-Based Anomaly Detector of Deformation in Insar." *IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING* 60 (2022). https://doi.org/10.1109/TGRS.2022.3169455.

41. Shakeel, Muhammad, Kenji Nishida, Katsutoshi Itoyama, and Kazuhiro Nakadai. "3d Convolution Recurrent Neural Networks for Multi-Label Earthquake Magnitude Classification." *APPLIED SCIENCES-BASEL* 12, no. 4 (2022). https://doi.org/10.3390/app12042195.
42. Shao, Jinyuan, Lina Tang, Ming Liu, Guofan Shao, Lang Sun, and Quanyi Qiu. "Bdd-Net: A General Protocol for Mapping Buildings Damaged by a Wide Range of Disasters Based on Satellite Imagery." *REMOTE SENSING* 12, no. 10 (2020). https://doi.org/10.3390/rs12101670.
43. Shokouhi, Parisa, Vrushali Girkar, Jacques Riviere, Srisharan Shreedharan, Chris Marone, C. Lee Giles, and Daniel Kifer. "Deep Learning Can Predict Laboratory Quakes from Active Source Seismic Data." *GEOPHYSICAL RESEARCH LETTERS* 48, no. 12 (2021). https://doi.org/10.1029/2021GL093187.
44. Siahkoohi, Ali, Gabrio Rizzuti, and Felix J. Herrmann. "Deep Bayesian Inference for Seismic Imaging with Tasks." *GEOPHYSICS* 87, no. 5 (2022): S281-S302. https://doi.org/10.1190/GEO2021-0666.1.
45. Su, Yulin, Guangzhi Rong, Yining Ma, Junwen Chi, Xingpeng Liu, Jiquan Zhang, and Tiantao Li. "Hazard Assessment of Earthquake Disaster Chains Based on Deep Learning-a Case Study of Mao County, Sichuan Province." *FRONTIERS IN EARTH SCIENCE* 9 (2022). https://doi.org/10.3389/feart.2021.683903.
46. Vemula, Sreenath, K. P. Sreejaya, and S. T. G. Raghukanth. "Neural Network-Based Subduction Ground Motion Model and Its Application to New Zealand and the Andaman and Nicobar Islands." *JOURNAL OF EARTHQUAKE ENGINEERING* (2022). https://doi.org/10.1080/13632469.2022.2121333.
47. Xing, Ziyao, Xiaohui Su, Junming Liu, Wei Su, and Xiaodong Zhang. "Spatiotemporal Change Analysis of Earthquake Emergency Information Based on Microblog Data: A Case Study of the "8.8" Jiuzhaigou Earthquake." *ISPRS INTERNATIONAL JOURNAL OF GEO-INFORMATION* 8, no. 8 (2019). https://doi.org/10.3390/ijgi8080359.
48. Xing, Ziyao, Xiaodong Zhang, Xuli Zan, Cong Xiao, Bing Li, KeKe Han, Zhe Liu, and Junming Liu. "Crowdsourced Social Media and Mobile Phone Signaling Data for Disaster Impact Assessment: A Case Study of the 8.8 Jiuzhaigou Earthquake." *INTERNATIONAL JOURNAL OF DISASTER RISK REDUCTION* 58 (2021). https://doi.org/10.1016/j.ijdrr.2021.102200.
49. Yang, Tengfei, Jibo Xie, Guoqing Li, Naixia Mou, Zhenyu Li, Chuanzhao Tian, and Jing Zhao. "Social Media Big Data Mining and Spatio-Temporal Analysis on Public Emotions for Disaster Mitigation." *ISPRS INTERNATIONAL JOURNAL OF GEO-INFORMATION* 8, no. 1 (2019). https://doi.org/10.3390/ijgi8010029.
50. Yang, Xiaomei, Yongshan Chen, Shuai Teng, and Gongfa Chen. "A Novel Method for Predicting Local Site Amplification Factors Using 1-D Convolutional Neural Networks." *APPLIED SCIENCES-BASEL* 11, no. 24 (2021). https://doi.org/10.3390/app112411650.
51. Zhang, Shou, Bonhwa Ku, and Hanseok Ko. "Learnable Maximum Amplitude Structure for Earthquake Event Classification." *IEEE GEOSCIENCE AND REMOTE SENSING LETTERS* 19 (2022). https://doi.org/10.1109/LGRS.2022.3145387.
52. Zhang, Xiong, Jie Zhang, Congcong Yuan, Sen Liu, Zhibo Chen, and Weiping Li. "Locating Induced Earthquakes with a Network of Seismic Stations in Oklahoma Via a Deep Learning Method." *SCIENTIFIC REPORTS* 10, no. 1 (2020). https://doi.org/10.1038/s41598-020-58908-5.
53. Zhou, Huailai, Yangqin Guo, and Ke Guo. "Seismic Random Noise Attenuation Using a Tied-Weights Autoencoder Neural Network." *MINERALS* 11, no. 10 (2021). https://doi.org/10.3390/min11101089.
54. Muenchmeyer, Jannes, Dino Bindi, Ulf Leser, and Frederik Tilmann. "The Transformer Earthquake Alerting Model: A New Versatile Approach to Earthquake Early Warning." *GEOPHYSICAL JOURNAL INTERNATIONAL* 225, no. 1 (2021): 646-56. https://doi.org/10.1093/gji/ggaa609.

55. Duan, Yi, Yiran Shen, Ismet Canbulat, Xun Luo, and Guangyao Si. "Classification of Clustered Microseismic Events in a Coal Mine Using Machine Learning." *JOURNAL OF ROCK MECHANICS AND GEOTECHNICAL ENGINEERING* 13, no. 6 (2021): 1256-73. https://doi.org/10.1016/j.jrmge.2021.09.002.
56. Peng, Guili, Xianguo Tuo, Tong Shen, and Jing Lu. "Recognition of Rock Micro-Fracture Signal Based on Deep Convolution Neural Network Inception Algorithm." *IEEE ACCESS* 9 (2021): 89390-99. https://doi.org/10.1109/ACCESS.2021.3086630.
57. Wilkins, Andy H., Andrew Strange, Yi Duan, and Xun Luo. "Identifying Microseismic Events in a Mining Scenario Using a Convolutional Neural Network." *COMPUTERS & GEOSCIENCES* 137 (2020). https://doi.org/10.1016/j.cageo.2020.104418.
58. Wu, Yangxu, Jiaotong Wei, Jinxiao Pan, and Ping Chen. "Research on Microseismic Source Locations Based on Deep Reinforcement Learning." *IEEE ACCESS* 7 (2019): 39962-73. https://doi.org/10.1109/ACCESS.2019.2906066.
59. Xu, Haiyan, Yong Zhao, Tianhong Yang, Shuhong Wang, Yuqing Chang, and Peng Jia. "An Automatic P-Wave Onset Time Picking Method for Mining-Induced Microseismic Data Based on Long Short-Term Memory Deep Neural Network." *GEOMATICS NATURAL HAZARDS & RISK* 13, no. 1 (2022): 908-33. https://doi.org/10.1080/19475705.2022.2057241.
60. Aguilera, Quinton, Luigi Lombardo, Hakan Tanyas, and Aldo Lipani. "On the Prediction of Landslide Occurrences and Sizes Via Hierarchical Neural Networks." *STOCHASTIC ENVIRONMENTAL RESEARCH AND RISK ASSESSMENT* 36, no. 8 (2022): 2031-48. https://doi.org/10.1007/s00477-022-02215-0.
61. Aslam, Bilal, Adeel Zafar, and Umar Khalil. "Development of Integrated Deep Learning and Machine Learning Algorithm for the Assessment of Landslide Hazard Potential." *SOFT COMPUTING* 25, no. 21 (2021): 13493-512. https://doi.org/10.1007/s00500-021-06105-5.
62. Chowdhuri, Indrajit, Subodh Chandra Pal, Saeid Janizadeh, Asish Saha, Kourosh Ahmadi, Rabin Chakrabortty, Abu Reza Md Towfiqul Islam, Paramita Roy, and Manisa Shit. "Application of Novel Deep Boosting Framework-Based Earthquake Induced Landslide Hazards Prediction Approach in Sikkim Himalaya." *GEOCARTO INTERNATIONAL* (2022). https://doi.org/10.1080/10106049.2022.2068675.
63. Fu, Lv, Qi Zhang, Teng Wang, Weile Li, Qiang Xu, and Daqing Ge. "Detecting Slow-Moving Landslides Using Insar Phase-Gradient Stacking and Deep-Learning Network." *FRONTIERS IN ENVIRONMENTAL SCIENCE* 10 (2022). https://doi.org/10.3389/fenvs.2022.963322.
64. Fu, Rao, Jing He, Gang Liu, Weile Li, Jiaqi Mao, Minhui He, and Yuanyang Lin. "Fast Seismic Landslide Detection Based on Improved Mask R-Cnn." *REMOTE SENSING* 14, no. 16 (2022). https://doi.org/10.3390/rs14163928.
65. Gao, Zemin, and Mingtao Ding. "Application of Convolutional Neural Network Fused with Machine Learning Modeling Framework for Geospatial Comparative Analysis of Landslide Susceptibility." *NATURAL HAZARDS* 113, no. 2 (2022): 833-58. https://doi.org/10.1007/s11069-022-05326-7.
66. Ghorbanzadeh, Omid, Thomas Blaschke, Khalil Gholamnia, Sansar Raj Meena, Dirk Tiede, and Jagannath Aryal. "Evaluation of Different Machine Learning Methods and Deep-Learning Convolutional Neural Networks for Landslide Detection." *REMOTE SENSING* 11, no. 2 (2019). https://doi.org/10.3390/rs11020196.
67. Ghorbanzadeh, Omid, Sansar Raj Meena, Hejar Shahabi Sorman Abadi, Sepideh Tavakkoli Piralilou, Lv Zhiyong, and Thomas Blaschke. "Landslide Mapping Using Two Main Deep-Learning Convolution Neural Network Streams Combined by the Dempster-Shafer Model." *IEEE JOURNAL OF SELECTED TOPICS IN APPLIED EARTH OBSERVATIONS AND REMOTE SENSING* 14 (2021): 452-63. https://doi.org/10.1109/JSTARS.2020.3043836.
68. Habumugisha, Jules Maurice, Ningsheng Chen, Mahfuzur Rahman, Md Monirul Islam, Hilal Ahmad, Ahmed Elbeltagi, Gitika Sharma, Sharmina Naznin Liza, and Ashraf Dewan. "Landslide Susceptibility Mapping with Deep Learning Algorithms." *SUSTAINABILITY* 14, no. 3 (2022). https://doi.org/10.3390/su14031734.
69. Huang, Yu, Xu Han, and Liuyuan Zhao. "Recurrent Neural Networks for Complicated Seismic Dynamic Response Prediction of a Slope System." *ENGINEERING GEOLOGY* 289 (2021). https://doi.org/10.1016/j.enggeo.2021.106198.

70. Li, Yao, Peng Cui, Chengming Ye, Jose Marcato Junior, Zhengtao Zhang, Jian Guo, and Jonathan Li. "Accurate Prediction of Earthquake-Induced Landslides Based on Deep Learning Considering Landslide Source Area." *REMOTE SENSING* 13, no. 17 (2021). https://doi.org/10.3390/rs13173436.
71. Liu, Peng, Yongming Wei, Qinjun Wang, Jingjing Xie, Yu Chen, Zhichao Li, and Hongying Zhou. "A Research on Landslides Automatic Extraction Model Based on the Improved Mask R-Cnn." *ISPRS INTERNATIONAL JOURNAL OF GEO-INFORMATION* 10, no. 3 (2021). https://doi.org/10.3390/ijgi10030168.
72. Liu, Rui, Xin Yang, Chong Xu, Liangshuai Wei, and Xiangqiang Zeng. "Comparative Study of Convolutional Neural Network and Conventional Machine Learning Methods for Landslide Susceptibility Mapping." *REMOTE SENSING* 14, no. 2 (2022). https://doi.org/10.3390/rs14020321.
73. Nava, Lorenzo, Kushanav Bhuyan, Sansar Raj Meena, Oriol Monserrat, and Filippo Catani. "Rapid Mapping of Landslides on Sar Data by Attention U-Net." *REMOTE SENSING* 14, no. 6 (2022). https://doi.org/10.3390/rs14061449.
74. Pang, Dongdong, Gang Liu, Jing He, Weile Li, and Rao Fu. "Automatic Remote Sensing Identification of Co-Seismic Landslides Using Deep Learning Methods." *FORESTS* 13, no. 8 (2022). https://doi.org/10.3390/f13081213.
75. Qiao, Huijiao, Xue Wa, Youchuan Wan, Shengyang Li, and Wanfeng Zhang. "A Novel Change Detection Method for Natural Disaster Detection and Segmentation from Video Sequence." *SENSORS* 20, no. 18 (2020). https://doi.org/10.3390/s20185076.
76. Tang, Xiaochuan, Zihan Tu, Yu Wang, Mingzhe Liu, Dongfen Li, and Xuanmei Fan. "Automatic Detection of Coseismic Landslides Using a New Transformer Method." *REMOTE SENSING* 14, no. 12 (2022). https://doi.org/10.3390/rs14122884.
77. Wang, Siying, Xiaokun Lin, Xing Qi, Hongde Li, and Jingjing Yang. "Landslide Susceptibility Analysis Based on a Pso-Dbn Prediction Model in an Earthquake-Stricken Area." *FRONTIERS IN ENVIRONMENTAL SCIENCE* 10 (2022). https://doi.org/10.3389/fenvs.2022.912523.
78. Wei, Ruilong, Chengming Ye, Tianbo Sui, Yonggang Ge, Yao Li, and Jonathan Li. "Combining Spatial Response Features and Machine Learning Classifiers for Landslide Susceptibility Mapping." *INTERNATIONAL JOURNAL OF APPLIED EARTH OBSERVATION AND GEOINFORMATION* 107 (2022). https://doi.org/10.1016/j.jag.2022.102681.
79. Xiong, Yibing, Yi Zhou, Futao Wang, Shixin Wang, Jingming Wang, Jianwan Ji, and Zhenqing Wang. "Landslide Susceptibility Mapping Using Ant Colony Optimization Strategy and Deep Belief Network in Jiuzhaigou Region." *IEEE JOURNAL OF SELECTED TOPICS IN APPLIED EARTH OBSERVATIONS AND REMOTE SENSING* 14 (2021): 11042-57. https://doi.org/10.1109/JSTARS.2021.3122825.
80. Xu, Qingsong, Chaojun Ouyang, Tianhai Jiang, Xin Yuan, Xuanmei Fan, and Duoxiang Cheng. "Mffenet and Adanet: A Robust Deep Transfer Learning Method and Its Application in High Precision and Fast Cross-Scene Recognition of Earthquake-Induced Landslides." *LANDSLIDES* 19, no. 7 (2022): 1617-47. https://doi.org/10.1007/s10346-022-01847-1.
81. Yang, Ruilin, Feng Zhang, Junshi Xia, and Chuyi Wu. "Landslide Extraction Using Mask R-Cnn with Background-Enhancement Method." *REMOTE SENSING* 14, no. 9 (2022). https://doi.org/10.3390/rs14092206.
82. Yang, Xin, Rui Liu, Mei Yang, Jingjue Chen, Tianqiang Liu, Yuantao Yang, Wei Chen, and Yuting Wang. "Incorporating Landslide Spatial Information and Correlated Features among Conditioning Factors for Landslide Susceptibility Mapping." *REMOTE SENSING* 13, no. 11 (2021). https://doi.org/10.3390/rs13112166.
83. Yang, Zhiqiang, and Chong Xu. "Efficient Detection of Earthquake-Triggered Landslides Based on U-Net Plus Plus : An Example of the 2018 Hokkaido Eastern Iburi (Japan) Mw=6.6 Earthquake." *REMOTE SENSING* 14, no. 12 (2022). https://doi.org/10.3390/rs14122826.
84. Yi, Yaning, Zhijie Zhang, Wanchang Zhang, Huihui Jia, and Jianqiang Zhang. "Landslide Susceptibility Mapping Using Multiscale Sampling Strategy and Convolutional Neural Network: A Case Study in Jiuzhaigou Region." *CATENA* 195 (2020). https://doi.org/10.1016/j.catena.2020.104851.

85. Yu, Bo, Chong Xu, Fang Chen, Ning Wang, and Lei Wang. "Hadeennet: A Hierarchical-Attention Multi-Scale Deconvolution Network for Landslide Detection." *INTERNATIONAL JOURNAL OF APPLIED EARTH OBSERVATION AND GEOINFORMATION* 111 (2022). https://doi.org/10.1016/j.jag.2022.102853.
86. Zhang, Pengfei, Chong Xu, Siyuan Ma, Xiaoyi Shao, Yingying Tian, and Boyu Wen. "Automatic Extraction of Seismic Landslides in Large Areas with Complex Environments Based on Deep Learning: An Example of the 2018 Iburi Earthquake, Japan." *REMOTE SENSING* 12, no. 23 (2020). https://doi.org/10.3390/rs12233992.
87. Zhang, Sikui, Lin Bai, Yuanwei Li, Weile Li, and Mingli Xie. "Comparing Convolutional Neural Network and Machine Learning Models in Landslide Susceptibility Mapping: A Case Study in Wenchuan County." *FRONTIERS IN ENVIRONMENTAL SCIENCE* 10 (2022). https://doi.org/10.3389/fenvs.2022.886841.
88. Zheng, Huangyuying, Bin Liu, Suyue Han, Xinyue Fan, Tianyi Zou, Zhongli Zhou, and Hao Gong. "Research on Landslide Hazard Spatial Prediction Models Based on Deep Neural Networks: A Case Study of Northwest Sichuan, China." *ENVIRONMENTAL EARTH SCIENCES* 81, no. 9 (2022). https://doi.org/10.1007/s12665-022-10369-x.
89. Adriano, Bruno, Naoto Yokoya, Junshi Xia, Hiroyuki Miura, Wen Liu, Masashi Matsuoka, and Shunichi Koshimura. "Learning from Multimodal and Multitemporal Earth Observation Data for Building Damage Mapping." *ISPRS JOURNAL OF PHOTOGRAMMETRY AND REMOTE SENSING* 175 (2021): 132-43. https://doi.org/10.1016/j.isprsjprs.2021.02.016.
90. Bai, Yanbing, Chang Gao, Sameer Singh, Magaly Koch, Bruno Adriano, Erick Mas, and Shunichi Koshimura. "A Framework of Rapid Regional Tsunami Damage Recognition from Post-Event Terrasar-X Imagery Using Deep Neural Networks." *IEEE GEOSCIENCE AND REMOTE SENSING LETTERS* 15, no. 1 (2018): 43-47. https://doi.org/10.1109/LGRS.2017.2772349.
91. Bai, Yanbing, Erick Mas, and Shunichi Koshimura. "Towards Operational Satellite-Based Damage-Mapping Using U-Net Convolutional Network: A Case Study of 2011 Tohoku Earthquake-Tsunami." *REMOTE SENSING* 10, no. 10 (2018). https://doi.org/10.3390/rs10101626.
92. Nunez, Jorge, Patricio A. Catalan, Carlos Valle, Natalia Zamora, and Alvaro Valderrama. "Discriminating the Occurrence of Inundation in Tsunami Early Warning with One-Dimensional Convolutional Neural Networks." *SCIENTIFIC REPORTS* 12, no. 1 (2022). https://doi.org/10.1038/s41598-022-13788-9.
93. Sublime, Jeremie, and Ekaterina Kalinicheva. "Automatic Post-Disaster Damage Mapping Using Deep-Learning Techniques for Change Detection: Case Study of the Tohoku Tsunami." *REMOTE SENSING* 11, no. 9 (2019). https://doi.org/10.3390/rs11091123.
94. Adha, Augusta, Arya Pamuncak, Wen Qiao, and Irwanda Laory. "Automated Building Classification Framework Using Convolutional Neural Network." *COGENT ENGINEERING* 9, no. 1 (2022). https://doi.org/10.1080/23311916.2022.2065900.
95. Ahadzadeh, Sajjad, and Mohammad Reza Malek. "Earthquake Damage Assessment in Three Spatial Scale Using Naive Bayes, Svm, and Deep Learning Algorithms." *APPLIED SCIENCES-BASEL* 11, no. 20 (2021). https://doi.org/10.3390/app11209737.
96. Alcantara, Edisson Alberto Moscoso, and Taiki Saito. "Convolutional Neural Network-Based Rapid Post-Earthquake Structural Damage Detection: Case Study." *SENSORS* 22, no. 17 (2022). https://doi.org/10.3390/s22176426.
97. Cardellicchio, Angelo, Sergio Ruggieri, Valeria Leggieri, and Giuseppina Uva. "View Vulma: Data Set for Training a Machine-Learning Tool for a Fast Vulnerability Analysis of Existing Buildings." *DATA* 7, no. 1 (2022). https://doi.org/10.3390/data7010004.
98. Chen, Fang, and Bo Yu. "Earthquake-Induced Building Damage Mapping Based on Multi-Task Deep Learning Framework." *IEEE ACCESS* 7 (2019): 181396-404. https://doi.org/10.1109/ACCESS.2019.2958983.
99. Chen, Peng-Yu, Zheng Yi Wu, and Ertugrul Taciroglu. "Classification of Soft-Story Buildings Using Deep Learning with Density Features Extracted from 3d Point Clouds." *JOURNAL OF COMPUTING IN CIVIL ENGINEERING* 35, no. 3 (2021). https://doi.org/10.1061/(ASCE)CP.1943-5487.0000968.

100. Chida, Hiroyuki, and Noriyuki Takahashi. "Study on Image Diagnosis of Timber Houses Damaged by Earthquake Using Deep Learning." *JAPAN ARCHITECTURAL REVIEW* 4, no. 3 (2021): 420-30. https://doi.org/10.1002/2475-8876.12221.
101. Ci, Tianyu, Zhen Liu, and Ying Wang. "Assessment of the Degree of Building Damage Caused by Disaster Using Convolutional Neural Networks in Combination with Ordinal Regression." *REMOTE SENSING* 11, no. 23 (2019). https://doi.org/10.3390/rs11232858.
102. Crawford, P. Shane, Mohammad A. Al-Zarrad, Andrew J. Graettinger, Alexander M. Hainen, Edward Back, and Lawrence Powell. "Rapid Disaster Data Dissemination and Vulnerability Assessment through Synthesis of a Web-Based Extreme Event Viewer and Deep Learning." *ADVANCES IN CIVIL ENGINEERING* 2018 (2018). https://doi.org/10.1155/2018/7258156.
103. Ding, Jiujie, Jiahuan Zhang, Zongqian Zhan, Xiaofang Tang, and Xin Wang. "A Precision Efficient Method for Collapsed Building Detection in Post-Earthquake Uav Images Based on the Improved Nms Algorithm and Faster R-Cnn." *REMOTE SENSING* 14, no. 3 (2022). https://doi.org/10.3390/rs14030663.
104. Duarte, Diogo, Francesco Nex, Norman Kerle, and George Vosselman. "Multi-Resolution Feature Fusion for Image Classification of Building Damages with Convolutional Neural Networks." *REMOTE SENSING* 10, no. 10 (2018). https://doi.org/10.3390/rs10101636.
105. ———. "Detection of Seismic Facade Damages with Multi-Temporal Oblique Aerial Imagery." *GISCIENCE & REMOTE SENSING* 57, no. 5 (2020): 670-86. https://doi.org/10.1080/15481603.2020.1768768.
106. Ghione, Federica, Steffen Maeland, Abdelghani Meslem, and Volker Oye. "Building Stock Classification Using Machine Learning: A Case Study for Oslo, Norway." *FRONTIERS IN EARTH SCIENCE* 10 (2022). https://doi.org/10.3389/feart.2022.886145.
107. Gonzalez, Daniela, Diego Rueda-Plata, Ana B. Acevedo, Juan C. Duque, Raul Ramos-Pollan, Alejandro Betancourt, and Sebastian Garcia. "Automatic Detection of Building Typology Using Deep Learning Methods on Street Level Images." *BUILDING AND ENVIRONMENT* 177 (2020). https://doi.org/10.1016/j.buildenv.2020.106805.
108. Hong, Zhonghua, Yahui Yang, Jun Liu, Shenlu Jiang, Haiyan Pan, Ruyan Zhou, Yun Zhang, Yanling Han, Jing Wang, Shuhu Yang, and Changyue Zhong. "Enhancing 3d Reconstruction Model by Deep Learning and Its Application in Building Damage Assessment after Earthquake." *APPLIED SCIENCES-BASEL* 12, no. 19 (2022). https://doi.org/10.3390/app12199790.
109. Hong, Zhonghua, Hongzheng Zhong, Haiyan Pan, Jun Liu, Ruyan Zhou, Yun Zhang, Yanling Han, Jing Wang, Shuhu Yang, and Changyue Zhong. "Classification of Building Damage Using a Novel Convolutional Neural Network Based on Post-Disaster Aerial Images." *SENSORS* 22, no. 15 (2022). https://doi.org/10.3390/s22155920.
110. Hu, Yijiang, and Hong Tang. "On the Generalization Ability of a Global Model for Rapid Building Mapping from Heterogeneous Satellite Images of Multiple Natural Disaster Scenarios." *REMOTE SENSING* 13, no. 5 (2021). https://doi.org/10.3390/rs13050984.
111. Ji, Min, Lanfa Liu, and Manfred Buchroithner. "Identifying Collapsed Buildings Using Post-Earthquake Satellite Imagery and Convolutional Neural Networks: A Case Study of the 2010 Haiti Earthquake." *REMOTE SENSING* 10, no. 11 (2018). https://doi.org/10.3390/rs10111689.
112. Ji, Min, Lanfa Liu, Runlin Du, and Manfred F. Buchroithner. "A Comparative Study of Texture and Convolutional Neural Network Features for Detecting Collapsed Buildings after Earthquakes Using Pre- and Post-Event Satellite Imagery." *REMOTE SENSING* 11, no. 10 (2019). https://doi.org/10.3390/rs11101202.
113. Kaplan, Onur, and Gordana Kaplan. "Response Spectra-Based Post-Earthquake Rapid Structural Damage Estimation Approach Aided with Remote Sensing Data: 2020 Samos Earthquake." *BUILDINGS* 12, no. 1 (2022). https://doi.org/10.3390/buildings12010014.
114. Li, Jinke, Zheng He, and Xuefeng Zhao. "A Data-Driven Building's Seismic Response Estimation Method Using a Deep Convolutional Neural Network." *IEEE ACCESS* 9 (2021): 50061-77. https://doi.org/10.1109/ACCESS.2021.3065837.

115. Lin, Qigen, Tianyu Ci, Leibin Wang, Sanjit Kumar Mondal, Huaxiang Yin, and Ying Wang. "Transfer Learning for Improving Seismic Building Damage Assessment." *REMOTE SENSING* 14, no. 1 (2022). https://doi.org/10.3390/rs14010201.

116. Liu, Chaoxian, Haigang Sui, Jianxun Wang, Zixuan Ni, and Liang Ge. "Real-Time Ground-Level Building Damage Detection Based on Lightweight and Accurate Yolov5 Using Terrestrial Images." *REMOTE SENSING* 14, no. 12 (2022). https://doi.org/10.3390/rs14122763.

117. Ma, Haojie, Yalan Liu, Yuhuan Ren, Dacheng Wang, Linjun Yu, and Jingxian Yu. "Improved Cnn Classification Method for Groups of Buildings Damaged by Earthquake, Based on High Resolution Remote Sensing Images." *REMOTE SENSING* 12, no. 2 (2020). https://doi.org/10.3390/rs12020260.

118. Mangalathu, Sujith, and Henry V. Burton. "Deep Learning-Based Classification of Earthquake-Impacted Buildings Using Textual Damage Descriptions." *INTERNATIONAL JOURNAL OF DISASTER RISK REDUCTION* 36 (2019). https://doi.org/10.1016/j.ijdrr.2019.101111.

119. Miura, Hiroyuki, Tomohiro Aridome, and Masashi Matsuoka. "Deep Learning-Based Identification of Collapsed, Non-Collapsed and Blue Tarp-Covered Buildings from Post-Disaster Aerial Images." *REMOTE SENSING* 12, no. 12 (2020). https://doi.org/10.3390/rs12121924.

120. Park, Ju An, Xiaoyu Liu, Chul Min Yeum, Shirley J. Dyke, Max Midwinter, Jongseong Choi, Zhiwei Chu, Thomas Hacker, and Bedrich Benes. "Multioutput Image Classification to Support Postearthquake Reconnaissance." *JOURNAL OF PERFORMANCE OF CONSTRUCTED FACILITIES* 36, no. 6 (2022). https://doi.org/10.1061/(ASCE)CF.1943-5509.0001755.

121. Pelizari, Patrick Aravena, Christian Geiss, Paula Aguirre, Hernan Santa Maria, Yvonne Merino Pena, and Hannes Taubenboeck. "Automated Building Characterization for Seismic Risk Assessment Using Street-Level Imagery and Deep Learning." *ISPRS JOURNAL OF PHOTOGRAMMETRY AND REMOTE SENSING* 180 (2021): 370-86. https://doi.org/10.1016/j.isprsjprs.2021.07.004.

122. Qing, Yuanzhao, Dongping Ming, Qi Wen, Qihao Weng, Lu Xu, Yangyang Chen, Yi Zhang, and Beichen Zeng. "Operational Earthquake-Induced Building Damage Assessment Using Cnn-Based Direct Remote Sensing Change Detection on Superpixel Level." *INTERNATIONAL JOURNAL OF APPLIED EARTH OBSERVATION AND GEOINFORMATION* 112 (2022). https://doi.org/10.1016/j.jag.2022.102899.

123. Rueda-Plata, D., D. Gonzalez, A. B. Acevedo, J. C. Duque, and R. Ramos-Pollan. "Use of Deep Learning Models in Street-Level Images to Classify One-Story Unreinforced Masonry Buildings Based on Roof Diaphragms." *BUILDING AND ENVIRONMENT* 189 (2021). https://doi.org/10.1016/j.buildenv.2020.107517.

124. Seydi, Seyd Teymoor, Heidar Rastiveis, Bahareh Kalantar, Alfian Abdul Halin, and Naonori Ueda. "Bdd-Net: An End-to-End Multiscale Residual Cnn for Earthquake-Induced Building Damage Detection." *REMOTE SENSING* 14, no. 9 (2022). https://doi.org/10.3390/rs14092214.

125. Shen, Yu, Sijie Zhu, Taojiannan Yang, Chen Chen, Delu Pan, Jianyu Chen, Liang Xiao, and Qian Du. "Bdanet: Multiscale Convolutional Neural Network with Cross-Directional Attention for Building Damage Assessment from Satellite Images." *IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING* 60 (2022). https://doi.org/10.1109/TGRS.2021.3080580.

126. Shi, Lingfei, Feng Zhang, Junshi Xia, Jibo Xie, Zhe Zhang, Zhenhong Du, and Renyi Liu. "Identifying Damaged Buildings in Aerial Images Using the Object Detection Method." *REMOTE SENSING* 13, no. 21 (2021). https://doi.org/10.3390/rs13214213.

127. Tsuchimoto, Koji, Yasutaka Narazaki, Vedhus Hoskere, and Billie F. Spencer. "Rapid Postearthquake Safety Evaluation of Buildings Using Sparse Acceleration Measurements." *STRUCTURAL HEALTH MONITORING-AN INTERNATIONAL JOURNAL* 20, no. 4 (2021): 1822-40. https://doi.org/10.1177/1475921720936296.

128. Tsuchimoto, Koji, Yasutaka Narazaki, and Billie F. Spencer, Jr. "Development and Validation of a Post-Earthquake Safety Assessment System for High-Rise Buildings Using Acceleration Measurements." *MATHEMATICS* 9, no. 15 (2021). https://doi.org/10.3390/math9151758.
129. Wang, Chaofeng, Sarah Elizabeth Antos, and Luis Miguel Triveno. "Automatic Detection of Unreinforced Masonry Buildings from Street View Images Using Deep Learning-Based Image Segmentation." *AUTOMATION IN CONSTRUCTION* 132 (2021). https://doi.org/10.1016/j.autcon.2021.103968.
130. Wang, Yu, Liangyi Cui, Chenzong Zhang, Wenli Chen, Yang Xu, and Qiangqiang Zhang. "A Two-Stage Seismic Damage Assessment Method for Small, Dense, and Imbalanced Buildings in Remote Sensing Images." *REMOTE SENSING* 14, no. 4 (2022). https://doi.org/10.3390/rs14041012.
131. Xiu, Haoyi, Takayuki Shinohara, Masashi Matsuoka, Munenari Inoguchi, Ken Kawabe, and Kei Horie. "Collapsed Building Detection Using 3d Point Clouds and Deep Learning." *REMOTE SENSING* 12, no. 24 (2020). https://doi.org/10.3390/rs12244057.
132. Yeum, Chul Min, Shirley J. Dyke, and Julio Ramirez. "Visual Data Classification in Post-Event Building Reconnaissance." *ENGINEERING STRUCTURES* 155 (2018): 16-24. https://doi.org/10.1016/j.engstruct.2017.10.057.
133. Zhan, Yihao, Wen Liu, and Yoshihisa Maruyama. "Damaged Building Extraction Using Modified Mask R-Cnn Model Using Post-Event Aerial Images of the 2016 Kumamoto Earthquake." *REMOTE SENSING* 14, no. 4 (2022). https://doi.org/10.3390/rs14041002.
134. Soleimani-Babakamali, Mohammad Hesam, and Mohsen Zaker Esteghamati. "Estimating Seismic Demand Models of a Building Inventory from Nonlinear Static Analysis Using Deep Learning Methods." *ENGINEERING STRUCTURES* 266 (2022). https://doi.org/10.1016/j.engstruct.2022.114576.
135. Song, Dongmei, Xuan Tan, Bin Wang, Ling Zhang, Xinjian Shan, and Jianyong Cui. "Integration of Super-Pixel Segmentation and Deep-Learning Methods for Evaluating Earthquake-Damaged Buildings Using Single-Phase Remote Sensing Imagery." *INTERNATIONAL JOURNAL OF REMOTE SENSING* 41, no. 3 (2020): 1040-66. https://doi.org/10.1080/01431161.2019.1655175.
136. Alcantara, Edisson Alberto Moscoso, Michelle Diana Bong, and Taiki Saito. "Structural Response Prediction for Damage Identification Using Wavelet Spectra in Convolutional Neural Network." *SENSORS* 21, no. 20 (2021). https://doi.org/10.3390/s21206795.
137. Dang, Hung V., Mohsin Raza, Tung V. Nguyen, T. Bui-Tien, and Huan X. Nguyen. "Deep Learning-Based Detection of Structural Damage Using Time-Series Data." *STRUCTURE AND INFRASTRUCTURE ENGINEERING* 17, no. 11 (2021): 1474-93. https://doi.org/10.1080/15732479.2020.1815225.
138. Eshkevari, Soheil Sadeghi, Martin Takac, Shamim N. Pakzad, and Majid Jahani. "Dynnet: Physics-Based Neural Architecture Design for Nonlinear Structural Response Modeling and Prediction." *ENGINEERING STRUCTURES* 229 (2021). https://doi.org/10.1016/j.engstruct.2020.111582.
139. Gao, Yuqing, and Khalid M. Mosalam. "Peer Hub Imagenet: A Large-Scale Multiattribute Benchmark Data Set of Structure Images." *JOURNAL OF STRUCTURAL ENGINEERING* 146, no. 10 (2020). https://doi.org/10.1061/(ASCE)ST.1943-541X.0002745.
140. Ghahremani, Behzad, Maryam Bitaraf, Amir K. Ghorbani-Tanha, and Reza Fallahi. "Structural Damage Identification Based on Fast S-Transform and Convolutional Neural Networks." *STRUCTURES* 29 (2021): 1199-209. https://doi.org/10.1016/j.istruc.2020.11.068.
141. Haciefendioglu, Kemal, Hasan Basri Basaga, and Gokhan Demir. "Automatic Detection of Earthquake-Induced Ground Failure Effects through Faster R-Cnn Deep Learning-Based Object Detection Using Satellite Images." *NATURAL HAZARDS* 105, no. 1 (2021): 383-403. https://doi.org/10.1007/s11069-020-04315-y.

142. Ji, Xiaodong, Yuncheng Zhuang, Zenghui Miao, and Yuhao Cheng. "Vision-Based Seismic Damage Detection and Residual Capacity Assessment for an Rc Shaking Table Test Structure." *EARTHQUAKE ENGINEERING & STRUCTURAL DYNAMICS* 52, no. 3 (2023): 806-27. https://doi.org/10.1002/eqe.3788.

143. Kalantar, Bahareh, Naonori Ueda, Husam A. H. Al-Najjar, and Alfian Abdul Halin. "Assessment of Convolutional Neural Network Architectures for Earthquake-Induced Building Damage Detection Based on Pre- and Post-Event Orthophoto Images." *REMOTE SENSING* 12, no. 21 (2020). https://doi.org/10.3390/rs12213529.

144. Liu, Heng, and Yunfeng Zhang. "Deep Learning-Based Brace Damage Detection for Concentrically Braced Frame Structures under Seismic Loadings." *ADVANCES IN STRUCTURAL ENGINEERING* 22, no. 16 (2019): 3473-86. https://doi.org/10.1177/1369433219859389.

145. Mangalathu, Sujith, and Jong-Su Jeon. "Ground Motion-Dependent Rapid Damage Assessment of Structures Based on Wavelet Transform and Image Analysis Techniques." *JOURNAL OF STRUCTURAL ENGINEERING* 146, no. 11 (2020). https://doi.org/10.1061/(ASCE)ST.1943-541X.0002793.

146. Miao, Zenghui, Xiaodong Ji, Minghui Wu, and Xiang Gao. "Deep Learning-Based Evaluation for Mechanical Property Degradation of Seismically Damaged Rc Columns." *EARTHQUAKE ENGINEERING & STRUCTURAL DYNAMICS* (2022). https://doi.org/10.1002/eqe.3749.

147. Mondal, Tarutal Ghosh, Mohammad R. Jahanshahi, Rih-Teng Wu, and Zheng Yi Wu. "Deep Learning-Based Multi-Class Damage Detection for Autonomous Post-Disaster Reconnaissance." *STRUCTURAL CONTROL & HEALTH MONITORING* 27, no. 4 (2020). https://doi.org/10.1002/stc.2507.

148. Morales-Valdez, Jesus, Mario Lopez-Pacheco, and Wen Yu. "Automated Damage Location for Building Structures Using the Hysteretic Model and Frequency Domain Neural Networks." *STRUCTURAL CONTROL & HEALTH MONITORING* 27, no. 9 (2020). https://doi.org/10.1002/stc.2584.

149. Nex, Francesco, Diogo Duarte, Fabio Giulio Tonolo, and Norman Kerle. "Structural Building Damage Detection with Deep Learning: Assessment of a State-of-the-Art Cnn in Operational Conditions." *REMOTE SENSING* 11, no. 23 (2019). https://doi.org/10.3390/rs11232765.

150. Ni, Xiangyong, Qingsong Xiong, Qingzhao Kong, and Cheng Yuan. "Deep Hystereticnet to Predict Hysteretic Performance of Rc Columns against Cyclic Loading." *ENGINEERING STRUCTURES* 273 (2022). https://doi.org/10.1016/j.engstruct.2022.115103.

151. Ogunjinmi, Peter Damilola, Sung-Sik Park, Bubryur Kim, and Dong-Eun Lee. "Rapid Post-Earthquake Structural Damage Assessment Using Convolutional Neural Networks and Transfer Learning." *SENSORS* 22, no. 9 (2022). https://doi.org/10.3390/s22093471.

152. Pantoja-Rosero, B. G., D. Oner, M. Kozinski, R. Achanta, P. Fua, F. Perez-Cruz, and K. Beyer. "Topo-Loss for Continuity-Preserving Crack Detection Using Deep Learning." *CONSTRUCTION AND BUILDING MATERIALS* 344 (2022). https://doi.org/10.1016/j.conbuildmat.2022.128264.

153. Rezaie, Amir, Michele Godio, and Katrin Beyer. "Investigating the Cracking of Plastered Stone Masonry Walls under Shear-Compression Loading." *CONSTRUCTION AND BUILDING MATERIALS* 306 (2021). https://doi.org/10.1016/j.conbuildmat.2021.124831.

154. Tang, Zhiyi, Yuequan Bao, and Hui Li. "Group Sparsity-Aware Convolutional Neural Network for Continuous Missing Data Recovery of Structural Health Monitoring." *STRUCTURAL HEALTH MONITORING-AN INTERNATIONAL JOURNAL* 20, no. 4 (2021): 1738-59. https://doi.org/10.1177/1475921720931745.

155. Tilon, Sofia, Francesco Nex, Norman Kerle, and George Vosselman. "Post-Disaster Building Damage Detection from Earth Observation Imagery Using Unsupervised and Transferable Anomaly Detecting Generative Adversarial Networks." *REMOTE SENSING* 12, no. 24 (2020). https://doi.org/10.3390/rs12244193.

156. Xiong, Chen, Jie Zheng, Liangjin Xu, Chengyu Cen, Ruihao Zheng, and Yi Li. "Multiple-Input Convolutional Neural Network Model for Large-Scale Seismic Damage Assessment of Reinforced Concrete Frame Buildings." *APPLIED SCIENCES-BASEL* 11, no. 17 (2021). https://doi.org/10.3390/app11178258.
157. Yang, Wanting, Xianfeng Zhang, and Peng Luo. "Transferability of Convolutional Neural Network Models for Identifying Damaged Buildings Due to Earthquake." *REMOTE SENSING* 13, no. 3 (2021). https://doi.org/10.3390/rs13030504.
158. Yu, Yang, Chaoyue Wang, Xiaoyu Gu, and Jianchun Li. "A Novel Deep Learning-Based Method for Damage Identification of Smart Building Structures." *STRUCTURAL HEALTH MONITORING-AN INTERNATIONAL JOURNAL* 18, no. 1 (2019): 143-63. https://doi.org/10.1177/1475921718804132.
159. Yuan, Xinzhe, Dustin Tanksley, Pu Jiao, Liujun Li, Genda Chen, and Donald Wunsch. "Encoding Time-Series Ground Motions as Images for Convolutional Neural Networks-Based Seismic Damage Evaluation." *FRONTIERS IN BUILT ENVIRONMENT* 7 (2021). https://doi.org/10.3389/fbuil.2021.660103.
160. Yuan, Xinzhe, Dustin Tanksley, Liujun Li, Haibin Zhang, Genda Chen, and Donald Wunsch. "Faster Post-Earthquake Damage Assessment Based on 1d Convolutional Neural Networks." *APPLIED SCIENCES-BASEL* 11, no. 21 (2021). https://doi.org/10.3390/app11219844.
161. Yuan, Xing, Yao Zhang, Qinggang Lu, Shuhang Zhang, Hua Liu, Mingchang Jin, and Feng Xu. "Cycle Performance of Aerated Lightweight Concrete Windowed and Windowless Wall Panel from the Perspective of Lightweight Deep Learning." *COMPUTATIONAL INTELLIGENCE AND NEUROSCIENCE* 2022 (2022). https://doi.org/10.1155/2022/3968607.
162. Zhang, Lingxin, Junkai Shen, and Baijie Zhu. "A Research on an Improved Unet-Based Concrete Crack Detection Algorithm." *STRUCTURAL HEALTH MONITORING-AN INTERNATIONAL JOURNAL* 20, no. 4 (2021): 1864-79. https://doi.org/10.1177/1475921720940068.
163. Zhang, Ruiyang, Yang Liu, and Hao Sun. "Physics-Guided Convolutional Neural Network (Phycnn) for Data-Driven Seismic Response Modeling." *ENGINEERING STRUCTURES* 215 (2020). https://doi.org/10.1016/j.engstruct.2020.110704.
164. Zheng, Ruihao, Chen Xiong, Xiangbin Deng, Qiangsheng Li, and Yi Li. "Assessment of Earthquake Destructive Power to Structures Based on Machine Learning Methods." *APPLIED SCIENCES-BASEL* 10, no. 18 (2020). https://doi.org/10.3390/app10186210.
165. Zou, Dujian, Ming Zhang, Zhilin Bai, Tiejun Liu, Ao Zhou, Xi Wang, Wei Cui, and Shaodong Zhang. "Multicategory Damage Detection and Safety Assessment of Post-Earthquake Reinforced Concrete Structures Using Deep Learning." *COMPUTER-AIDED CIVIL AND INFRASTRUCTURE ENGINEERING* 37, no. 9 (2022): 1188-204. https://doi.org/10.1111/mice.12815.
166. Fan, Gao, Jun Li, Hong Hao, and Yu Xin. "Data Driven Structural Dynamic Response Reconstruction Using Segment Based Generative Adversarial Networks." *ENGINEERING STRUCTURES* 234 (2021). https://doi.org/10.1016/j.engstruct.2021.111970.
167. Al Duhayyim, Mesfer, Areej A. Malibari, Abdullah Alharbi, Kallekh Afef, Ayman Yafoz, Raed Alsini, Omar Alghushairy, and Heba Mohsen. "Road Damage Detection Using the Hunger Games Search with Elman Neural Network on High-Resolution Remote Sensing Images." *REMOTE SENSING* 14, no. 24 (2022). https://doi.org/10.3390/rs14246222.
168. An, Hyojoon, and Jong-Han Lee. "Deep Neural Network for Prediction of Time-History Seismic Response of Bridges." *STRUCTURAL ENGINEERING AND MECHANICS* 83, no. 3 (2022): 401-13. https://doi.org/10.12989/sem.2022.83.3.401.
169. Ansari, Abdullah, K. S. Rao, A. K. Jain, and Anas Ansari. "Deep Learning Model for Predicting Tunnel Damages and Track Serviceability under Seismic Environment." *MODELING EARTH SYSTEMS AND ENVIRONMENT* (2022). https://doi.org/10.1007/s40808-022-01556-7.
170. Cheraghzade, Milad, and Milad Roohi. "Deep Learning for Seismic Structural Monitoring by Accounting for Mechanics-Based Model Uncertainty." *JOURNAL OF BUILDING ENGINEERING* 57 (2022). https://doi.org/10.1016/j.jobe.2022.104837.

171. Hong, Zhonghua, Fan Yang, Haiyan Pan, Ruyan Zhou, Yun Zhang, Yanling Han, Jing Wang, Shuhu Yang, Peng Chen, Xiaohua Tong, and Jun Liu. "Highway Crack Segmentation from Unmanned Aerial Vehicle Images Using Deep Learning." *IEEE GEOSCIENCE AND REMOTE SENSING LETTERS* 19 (2022). https://doi.org/10.1109/LGRS.2021.3129607.

172. Li, Chunxiang, Hai Li, and Xu Chen. "Fast Seismic Response Estimation of Tall Pier Bridges Based on Deep Learning Techniques." *ENGINEERING STRUCTURES* 266 (2022). https://doi.org/10.1016/j.engstruct.2022.114566.

173. Nabian, Mohammad Amin, and Hadi Meidani. "Deep Learning for Accelerated Seismic Reliability Analysis of Transportation Networks." *COMPUTER-AIDED CIVIL AND INFRASTRUCTURE ENGINEERING* 33, no. 6 (2018): 443-58. https://doi.org/10.1111/mice.12359.

174. Naser, M. Z. "Enabling Cognitive and Autonomous Infrastructure in Extreme Events through Computer Vision." *INNOVATIVE INFRASTRUCTURE SOLUTIONS* 5, no. 3 (2020). https://doi.org/10.1007/s41062-020-00351-6.

175. Pang, YuTao, PengCheng Yin, JianGuo Wang, and Li Wu. "Integrated Framework for Seismic Fragility Assessment of Cable-Stayed Bridges Using Deep Learning Neural Networks." *SCIENCE CHINA-TECHNOLOGICAL SCIENCES* 66, no. 2 (2023): 406-16. https://doi.org/10.1007/s11431-022-2245-1.

176. Sajedi, Seyedomid, and Xiao Liang. "Filter Banks and Hybrid Deep Learning Architectures for Performance-Based Seismic Assessments of Bridges." *JOURNAL OF STRUCTURAL ENGINEERING* 148, no. 12 (2022). https://doi.org/10.1061/(ASCE)ST.1943-541X.0003501.

177. Silva-Lopez, Rodrigo, Jack W. Baker, and Alan Poulos. "Deep Learning-Based Retrofitting and Seismic Risk Assessment of Road Networks." *JOURNAL OF COMPUTING IN CIVIL ENGINEERING* 36, no. 2 (2022). https://doi.org/10.1061/(ASCE)CP.1943-5487.0001006.

178. Yang, Baolin, Shixin Wang, Yi Zhou, Futao Wang, Qiao Hu, Ying Chang, and Qing Zhao. "Extraction of Road Blockage Information for the Jiuzhaigou Earthquake Based on a Convolution Neural Network and Very-High-Resolution Satellite Images." *EARTH SCIENCE INFORMATICS* 13, no. 1 (2020): 115-27. https://doi.org/10.1007/s12145-019-00413-z.

179. Ye, Xiao-Wei, Si-Yuan Ma, Zhi-Xiong Liu, Yang Ding, Zhe-Xun Li, and Tao Jin. "Post-Earthquake Damage Recognition and Condition Assessment of Bridges Using Uav Integrated with Deep Learning Approach." *STRUCTURAL CONTROL & HEALTH MONITORING* 29, no. 12 (2022). https://doi.org/10.1002/stc.3128.

180. Yoon, Sungsik, Billie F. Spencer, Jr., Sangmok Lee, Hyung-Jo Jung, and In-Ho Kim. "A Novel Approach to Assess the Seismic Performance of Deteriorated Bridge Structures by Employing Uav-Based Damage Detection." *STRUCTURAL CONTROL & HEALTH MONITORING* 29, no. 7 (2022). https://doi.org/10.1002/stc.2964.

181. Bernabe, Sergio, Carlos Gonzalez, Adrian Fernandez, and Ujwala Bhangale. "Portability and Acceleration of Deep Learning Inferences to Detect Rapid Earthquake Damage from Vhr Remote Sensing Images Using Intel Openvino Toolkit." *IEEE JOURNAL OF SELECTED TOPICS IN APPLIED EARTH OBSERVATIONS AND REMOTE SENSING* 14 (2021): 6906-15. https://doi.org/10.1109/JSTARS.2021.3075961.

182. Ghasemi, Amin, and Max T. Stephens. "Building Clustering for Regional Seismic Response and Damage Analysis." *EARTHQUAKE SPECTRA* 38, no. 4 (2022): 2941-69. https://doi.org/10.1177/87552930221104838.

183. Ji, Kun, Chuanbin Zhu, Saman Yaghmaei-Sabegh, Jianqi Lu, Yefei Ren, and Ruizhi Wen. "Site Classification Using Deep-Learning-Based Image Recognition Techniques." *EARTHQUAKE ENGINEERING & STRUCTURAL DYNAMICS* (2022). https://doi.org/10.1002/eqe.3801.

184. Kim, Taeyong, Junho Song, and Oh-Sung Kwon. "Pre- and Post-Earthquake Regional Loss Assessment Using Deep Learning." *EARTHQUAKE ENGINEERING & STRUCTURAL DYNAMICS* 49, no. 7 (2020): 657-78. https://doi.org/10.1002/eqe.3258.

185. Koukouraki, Eftychia, Leonardo Vanneschi, and Marco Painho. "Few-Shot Learning for Post-Earthquake Urban Damage Detection." *REMOTE SENSING* 14, no. 1 (2022). https://doi.org/10.3390/rs14010040.

186. Lu, Xinzheng, Yongjia Xu, Yuan Tian, Barbaros Cetiner, and Ertugrul Taciroglu. "A Deep Learning Approach to Rapid Regional Post-Event Seismic Damage Assessment Using Time-Frequency Distributions of Ground Motions." *EARTHQUAKE ENGINEERING & STRUCTURAL DYNAMICS* 50, no. 6 (2021): 1612-27. https://doi.org/10.1002/eqe.3415.

187. Maqsoom, Ahsen, Bilal Aslam, Umer Khalil, Muhammad Asad Mehmood, Hassan Ashraf, and Ali Siddique. "An Integrated Approach Based Earthquake Risk Assessment of a Seismically Active and Rapidly Urbanizing Area in Northern Pakistan." *GEOCARTO INTERNATIONAL* (2022). https://doi.org/10.1080/10106049.2022.2105404.

188. Xiong, Chen, Qiangsheng Li, and Xinzheng Lu. "Automated Regional Seismic Damage Assessment of Buildings Using an Unmanned Aerial Vehicle and a Convolutional Neural Network." *AUTOMATION IN CONSTRUCTION* 109 (2020). https://doi.org/10.1016/j.autcon.2019.102994.

189. Xu, Zhigiang, Yumin Chen, Fan Yang, Tianyou Chu, and Hongyan Zhou. "A Postearthquake Multiple Scene Recognition Model Based on Classical Ssd Method and Transfer Learning." *ISPRS INTERNATIONAL JOURNAL OF GEO-INFORMATION* 9, no. 4 (2020). https://doi.org/10.3390/ijgi9040238.