



XXVII FIG CONGRESS

11-15 SEPTEMBER 2022

Warsaw, Poland

Volunteering
for the future –
Geospatial excellence
for a better living

Exploring geospatial methods of detecting rural vitality, vulnerability and versatility in rural regions in Bavaria

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3VRUT – Project Goal

- To derive a comprehensive and resilient method that integrates **socio-economic indicators** with **remote sensing data** in order to derive effective insights in where which rural villages are improving how in :
 - vitality,
 - vulnerability
 - versatility



(-> 3V)



Germany



Technical
University of
Munich



Japan



Remote Sensing
Technology
Center of Japan



Poland



Jan Kochanowski
University



Spain



Universitat
Politècnica de
Catalunya





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3VRUT – Project Work packages

WP No	WORK PACKAGE	PLANNED ACTIVITIES
WP0	Project management	4 activities
WP1	Data gathering and indicator selection	7 activities (initially 8)
WP2	3VRUT Model conception and calibrating	6 activities (initially 5)
WP3	3VRUT Model implementation and testing	4 activities
WP4	Project consolidation, policy recommendations and result dissemination	4 activities

Main Outcome Goals - 1

1. An integrated conceptualisation, methodology, and set of indicators to verify and validate the degree of vitality, vulnerability and versatility (3Vs) of rural towns using remote sensing, socio-economic data, telecommunication and mobile data, ground interviews and ethnography.
2. A digital report for the local governments (in the local language) that integrates the 3Vs in the diagnosis of the selected rural towns, for them to make the necessary action plans to meet the Sustainable Development Goals.

Main Outcome Goals - 2

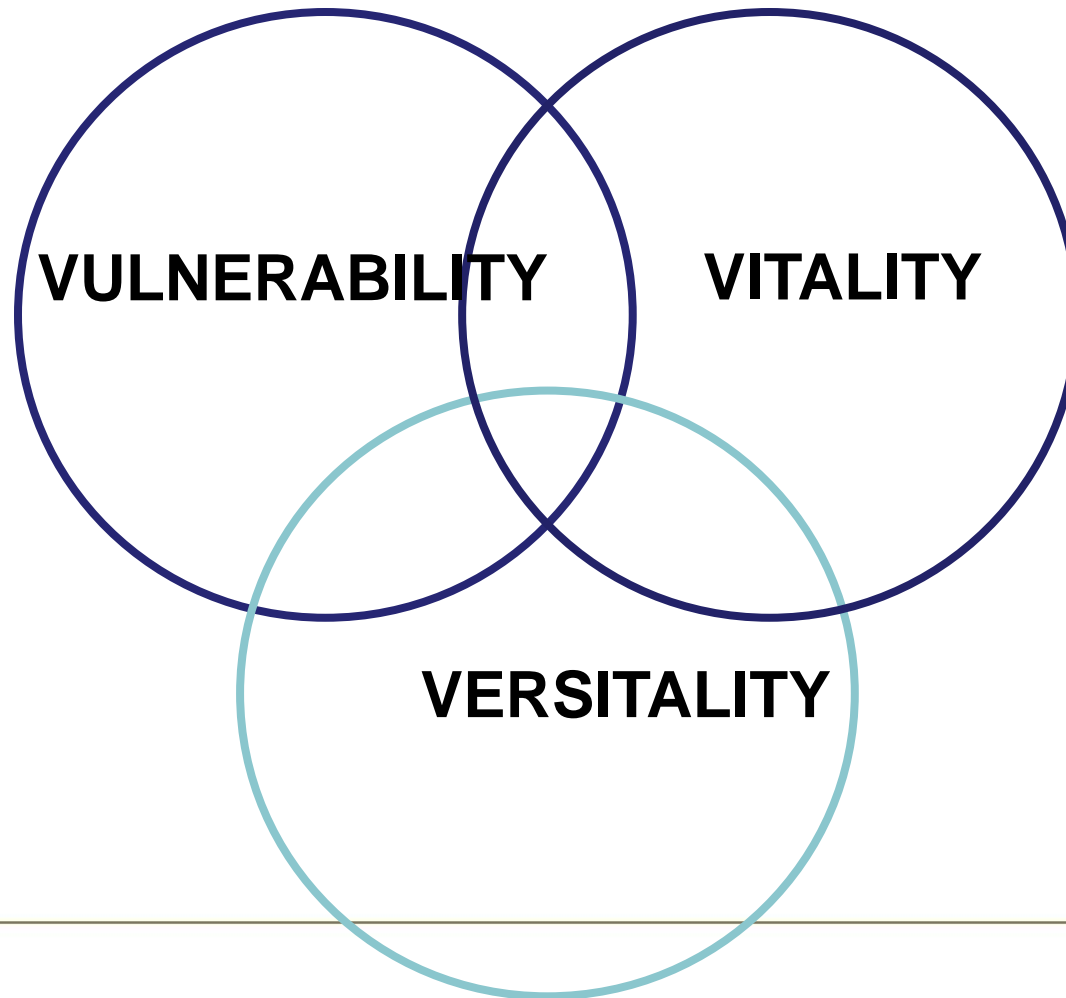
3. A documentary film with the research process and results as a teaching material that would explain the concept of the 3Vs in a practical way for it to be widely disseminated and replicated in other case studies.
4. Publication of results in three leading journals and international conferences.
5. A policy brief for discussions at the United Nations SDG Forum.
6. A start-up of transnational collaboration on land management and geospatial sciences.

Why Rural Towns?



Depopulation, migrations, tourism, climate change, connectivity, accessibility, mobility, unemployment

Why 3V?



Evaluate
Quantify
Classify



1

definition of
indicators and data
gathering



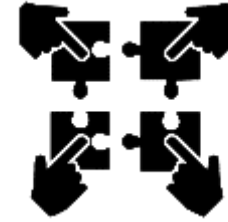
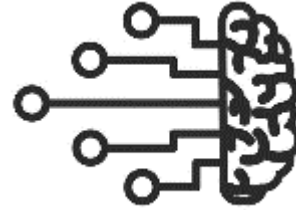
2

Data analysis and data
modelling
a) data modeling in time and
space
b) Patterns analysis in machine
learning



3

Modeling future
scenario to define
resilience
potentiality for
each one



3VRUT research project

Model → **Measure** → **Understand** → **Communicate** → **Action**

What is it important to define rural town resilience?



Indicators
5 dimensions
3 V
70 indicators

Gathering all the info about indicators + portrait of the towns (main trends & character)

Could be automated?
Machine learning?

Build resilience

Methodology - 3V assessment in 5 steps



3VRUT – Test cases



Shibushi

Bayrisch Eisenstein

Połaniec

Les Planes d'Hostoles

Tsukuba

Obermichelbach -Tuchenbach

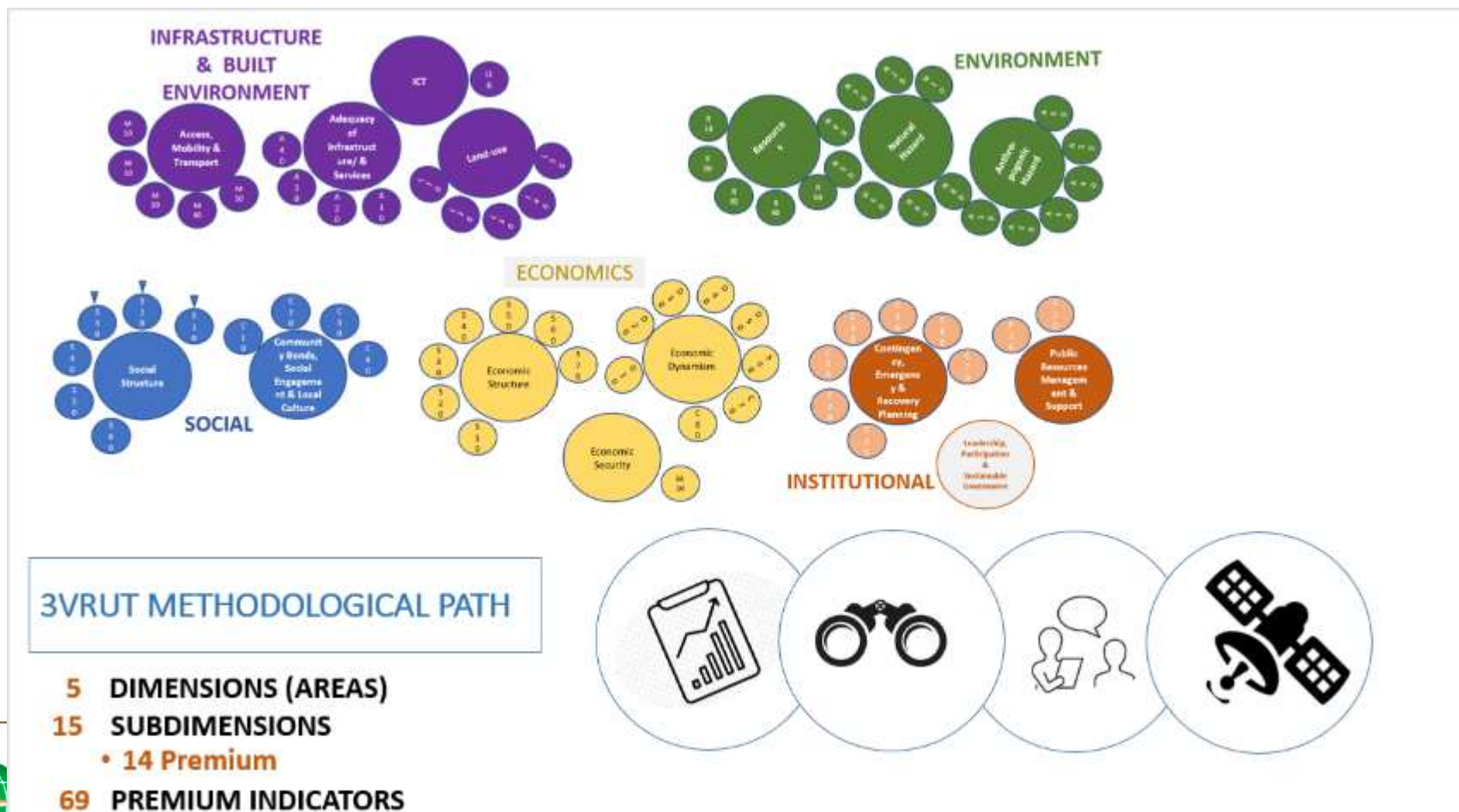
Bodzentyn

Alp

8 COMMUNITIES WITH DIFFERENT LEVELS OF VITALITY & VULNERABILITY



3VRUT – 3V conceptualisation & indicators





3VRUT – 3V conceptualisation & indicators - RS

Common applications of Remote sensing on vitality, vulnerability, and versatility

Topic	Indicator	Use in Disaster Phase	Used RS Data to Extract	Notes	Scale	Key Addresses
Structural building Damage/collapse	Number of damaged/collapsed buildings in the damaged area	Damage	VHR satellite images, Aerial images, UAV data		0	25,43,47
Shakes	To extract collapsed/damaged buildings/collapse in damaged buildings do not produce regular shake patterns	Damage	VHR satellite images, Aerial images		0	07,449,32,530
Tectonics	To extract damaged buildings, roads, and other areas (disrupts urban buildings) which indicate damaged areas	Damage, Vulnerability	HR and VHR data and satellite images		0	8,24,25,26,27,28,29,30,31,32
Building status	To extract building pre and post collapse	Damage	VHR satellite images		0	37
Roofing tile replacement or collapsed	To extract building damage ratio (degree of damaged roofs indicate damaged to buildings)	Damage	SAR images, VHR satellite images, UAV data		0	68,69,70,71
Building deformation	Damaged buildings have deformations in geometries including inclined building, discontinuous surface structure (crack)	Damage	Radar images, satellite images, UAV data, aerial video		0	48,70,72,73,74
Spalling building	Spalling building indicates damage to buildings	Damage	UAV data, VHR satellite images		0	75,76
Rebar piles and debris	To extract building damage ratio	Damage	UAV data, VHR satellite images		0	77,78,79,76,77,78
Value of post height change	Change in building height to detect collapsed buildings (collapsed building has lower height value than intact one)	Damage	VHR remote sensing height data (UAV data)		0	56
Walls and Facades with Cracks	To extract building damage ratio	Damage	UAV data, Radar data, Aerial images		0	68,70,83,84
Holes in gaps on roof and facade of the structures	To extract building damage ratio	Damage	UAV data		0	40,70,71,81,84,85
Intersection of cracks with structural element	To extract building damage ratio	Damage	UAV data		0	68,70
Level symmetry pattern of facade Windows	Change in the window pattern from its original to render one shows damage	Damage	Ortho aerial images		0	56
Building removal and reconstruction	Number of reconstructed buildings (three phases in recovery process)	Recovery	VHR satellite images, Aerial images		0	32,38,46,47,48,49, 67,73,84,85,86
Building explosion	Morphology of a building is prior for building structural structures, and change in the post from pre- to post-disaster destruction (see changes in recovery process)	Recovery, Vulnerability	VHR satellite images		0	32,38,68,69,87,88
Energy Loss	Lower energy loss value shows better condition of house	Recovery	VHR images		0	48
Position of building in relation to the street level	The difference between elevation of building to street (building to lower elevation in relation to street level more vulnerable)	Vulnerability	VHR satellite images, DEM data		0	88,91
Building overloads	To measure the structural overcapacity and resistance of various load based buildings are more robust than weaker ones in same related	Vulnerability, Resilience	VHR images, Other way		0	41,42,43,44,45,46

Study cases

Yubari, Japan



Zabierzów, Poland



Obermichelbach, Germany



Alp, Spain



Tskuba, Japan



Olesno, Poland



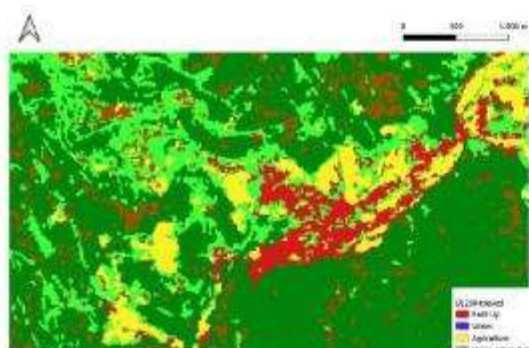
Bayrisch Eisenstein, Germany



Les Planes d'Hostoles, Spain



3VRUT – Project challenges



Class	2004			2021			Change (%age)
	Pixel Sum	%age	Area (sq. mt.)	Pixel Sum	%age	Area (sq. mt.)	
Built-up	46120	7.44	1037700	29590	0.047	6657750	-36
Water	0	0	0	3760	0.006	846000	0
Agriculture	52900	8.53	11902500	14530	0.023	3269250	-73
Commercial	0	0.00	0	6060	0.009	1363500	0
Forest	35080	56.59	78930000	34940	0.563	78615000	0
Grass	12227	19.72	27510750	19817	0.319	44588250	62
Bare	47830	7.72	10761750	18410	0.029	4142250	-62



Cases Tuchenbach and Bayerisch Eisenstein - Bavaria

- Tuchenbach is surrounded by fields (Wheat, corn and empty / harvested fields)
- Almost all private homes have swimming pools which have been captured in the classification
- Most private houses are using solar energy which is clearly visible in the orthophotos and efforts have been made to classify
- It has industrial area but it could not be treated as a separate class so merged with Built up
- There are no private swimming pools in Bayerisch Eisenstein
- There are no fields Bayerisch Eisenstein it is more forested
- In case of Tuchenbach there is a change in area in almost every class
- Lot of misclassified pixels in the classification of Bayerisch Eisenstein

Orthophoto at 40 cm resolution for Rural Town of Tuchenbach

2005



2017



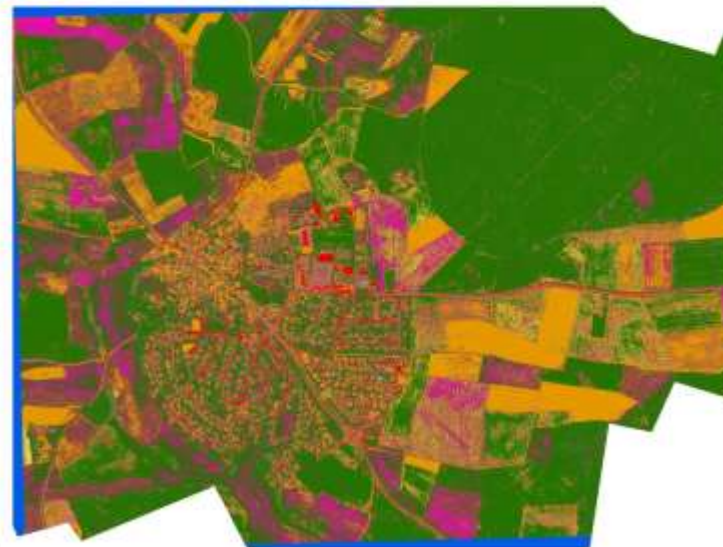
2011



2005



2017



CLASS

- Power lines
- Fields
- Corn fields
- Wheat fields
- Gravel Roads
- Cemetery
- Built_up
- Lawns
- Solar Panels
- Street
- Forest
- Artificial Water
- Naturak Water
- Meadows



Land use / land cover changes

CLASS	2005		2017		Change Area Sq Km	%age Change
	AREA_Sq cm	AREA_Sq_KM	AREA Sq Cm	AREA_Sq KM		
Power lines	15920	0.000002	26860921600	2.686092	2.69	0.17
Fields	108847280	0.010885	5833214400	0.583321	0.57	0.04
Corn Fields	46656000	0.004666	17773928000	1.777393	1.77	0.11
Wheat Fields	25759480	0.002576	700940800	0.070094	0.07	0.00
Gravel Roads	182644440	0.018264	6480086400	0.648009	0.63	0.04
Cemetery	17240	0.000002	5746608000	0.574661	0.57	0.04
Built_up	39195280	0.000001	7678164800	0.765238	0.77	0.05
Lawns	530440	0.000053	236540800	0.023654	0.02	0.00
Solar panels	5600	0.000001	2293662400	0.229366	0.23	0.01
Street	880	0.000000	1130244800	0.113024	0.11	0.01
Forest	314207560	0.031421	33396465600	3.339647	3.31	0.21
Artificial Water	51319720	0.005132	11445521600	1.144552	1.14	0.07
Natural water	285840	0.000029	38598865600	3.859887	3.86	0.25
Meadows	220922360	0.022092	281390400	0.028139	0.01	0.00

Orthophoto at 40 cm Resolution for the Rural town of Bayerisch Eisentein

2004



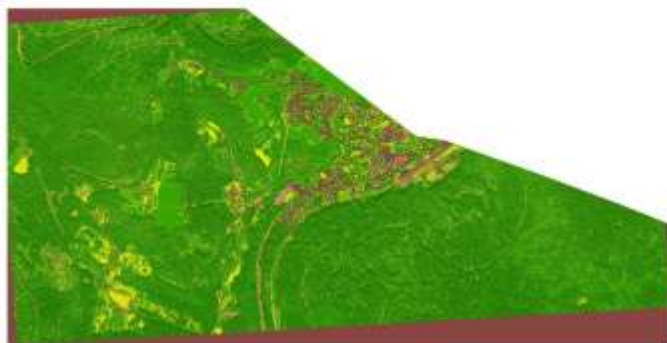
2010



2016








2004



2016

CLASS

-  Built_up
-  Cemetery
-  Fields
-  Forest
-  Meadow
-  Rail lines
-  Roads
-  Solar Panels
-  Water



2004		2016					
CLASS	AREA	AREA_SQKM	AREA	AREA_SQKM	Change Sq Km	Change in % age	
Rail lines	585692800	0.058569	326400	0.000033	-0.06	-0.01	
Roads	11312587200	1.131259	1002075200	0.100208	-1.03	-0.12	
Water	252164800	0.025216	722812800	0.072281	0.05	0.01	
Meadow	32251636800	3.225164	156145600	0.015615	-3.21	-0.38	
Built_up	159964800	0.015996	10354731200	1.035473	1.02	0.12	
Solar Panels	118182400	0.011818	474497600	0.047450	0.04	0.00	
Built_up	686017600	0.068602	113108800	0.011311	-0.06	-0.01	
Roads	596800	0.000060	13308800	0.001331	0.00	0.00	
Forest	32265017600	3.226502	59054896000	5.905490	2.68	0.31	
Cemetery	516736000	0.051674	434542400	0.043454	-0.01	0.00	
Fields	7166529600	0.716653	12988681600	1.298868	0.58	0.07	

Challenges when combining statistical data with remote sensing data

- Different spatial scales - > administrative boundaries – land use / land cover units ; spatial statistics at regional or municipal level
- Different time scales
- Different contextual and thematic environments
- Different cultures of defining and detecting what is important and relevant (change)



3VRUT – Upcoming steps

- Testing automated / machine remote sensing procedure to detect 3Vs in Japan case area
- Connect deliverables to field observations using indicator matrix
- Evaluate fit – mismatch – missing insights
- Connect (revised) RS data & procedures with (revised) indicator matrix
- Test in other case areas

Deliverables



- Revised set of 3V concepts and indicators
- Revised procedure of machine based RS detection of 3V
- Peer-reviewed papers (publication plan)
- Plan to upscale 3V at larger areas / multiple towns