Felix Arba – reconstructing urban and rural economic capacities through GIS

Lipovac Vrkljan, Goranka; Konestra, Ana; Šegvić, Nera

Mapping urban changes

Mapiranje urbanih promjena

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edited by / uredila
Ana Plosnić Škarić

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Dubrovnik: Civitas et Acta Consiliorum
Visualizing Development of the Late Medieval Urban Fabric

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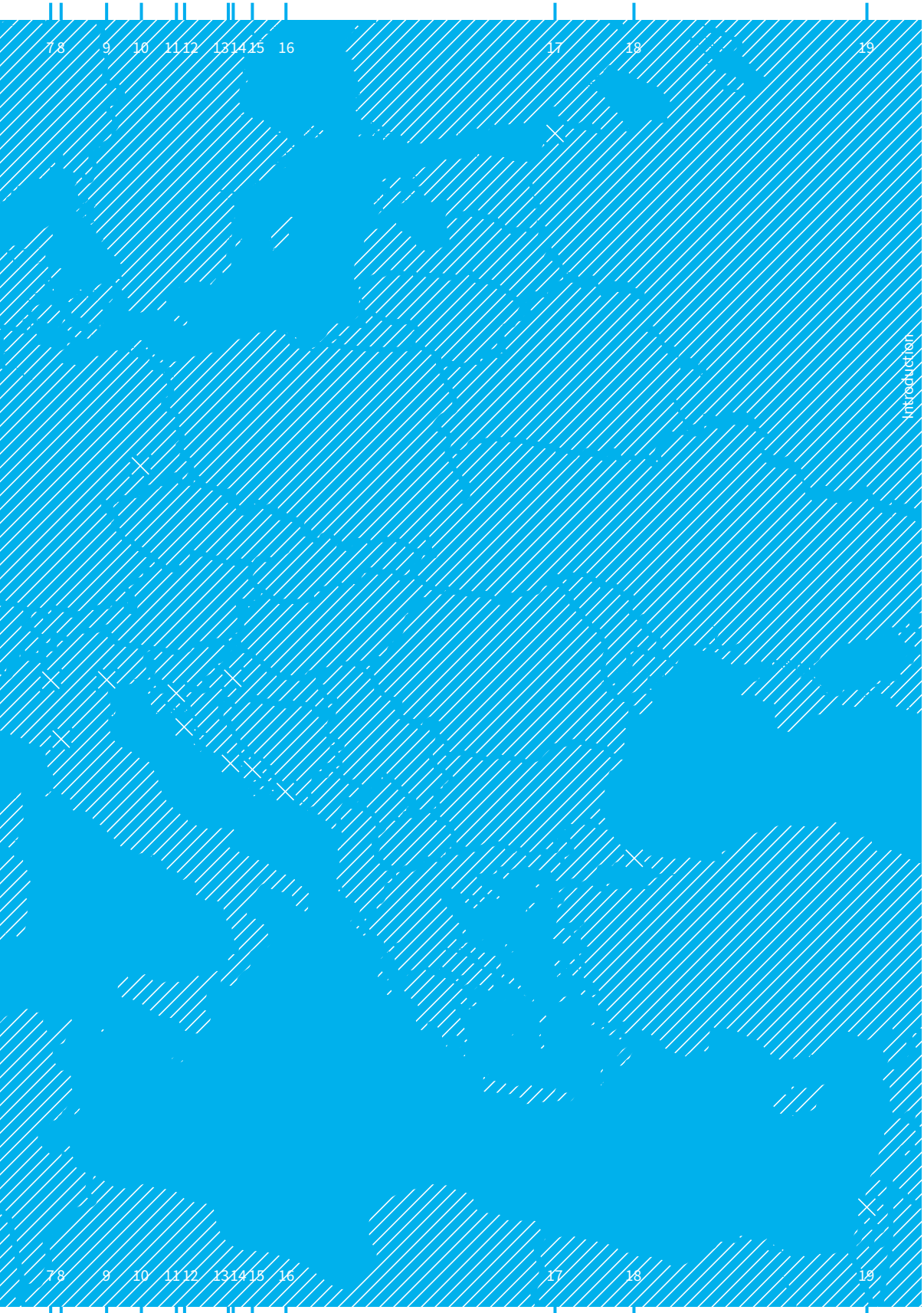

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Felix Arba – reconstructing urban and rural economic capacities through GIS*

Goranka Lipovac Vrkljan
Ana Konestra
Nera Šegvić

Most historic towns along the Adriatic coast and islands have lived through a multitude of administrations, wars, different economic conditions, being shaped by many phases of building and destruction, often reflecting the current state of affairs in the wider Adriatic and European region. As cities are not entities existing on their own but are part of a complex system involving their rural hinterland,[1] communications and nearby urban realities, they can be regarded in correlation to the balance within this structure.

Following these concepts, the subject of our analysis is the historic town of Rab, and its insular hinterland. Data collected through field survey within the projects *Archaeological topography of the island of Rab* (Ministry of Culture) and *RED: Roman economy in Dalmatia* (HRZZ)[2] will be the basis for the discussion on the development of the town and its insular rural hinterland in the 1st millennium AD. Limited by the lack of excavations, a new approach was pursued to analyse earlier information together with new data. Inspired by new surveys showing a substantial presence of rural sites which can so far be dated to later-Roman times, some with onward occupation continuity, our intention was to compare the two realities, urban and rural, and try to see if any, and which, interdependencies would arise. As both spatio-temporal issues emerge, authors address both assuming aforementioned "urban-rural relationship", while applying appropriate analytical models, to make the most of the ambiguous data.

In doing so, the Roman ruralscape is seen as a generator of surplus (and thus wealth), instead of a self-sufficient entity, interacting with the nearby town, providing the products and goods, all within the shared limits of their landscape.[3] Accordingly, we will try to establish whether the development of the city can be traced through the monuments' spatio-temporal distribution and whether these changes are also evidenced in other areas of the island. If changes can indeed be traced in both areas, the question is whether they can be regarded as correlated through both spatio-temporal associations or whether different processes developed in different parts of the island.

The city and the island of Rab are suitable for such analysis, as the island is, compared with the surrounding ones, rather small (93.6 km^2). What geologically differentiates Rab from the surrounding karst landscape is the presence of large flysh fields and the rich system of temporary and permanent streams.[4] Also, Rab fits into the Mediterranean zone (Csa),[5] creating perfect conditions for rural exploitation and different productive activities.

The Rab GIS

As archaeology is a fundamentally spatial discipline, the use of GIS seems almost self-explanatory. Longley et al.[6] name several important arguments advocating using GIS in research, all of which are conditioned by the quality of the underlying spatial database. The main aims of the Rab database are

standardisation, storage, manipulation, visualisation and analysis of the data compiled from the field surveys undertaken on the island from 2013 onwards, data registered in the National Inventory of Cultural Heritage and data recorded in archival and literature sources. This heterogeneity in data sources demanded unification and standardisation in addition to the compilation of various cartographic sources before the data could be analysed.

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The basic conceptual schema of the database is given in FIGURE 1. The database is defined by three core archaeological levels with spatial representations, Sites, Features and Finds, the basis of which is a unique code enabling the interconnectivity of the entities.

The core levels are further supplemented with subsidiary levels such as Archival, Literature Sources, and Survey conditions to mention a few. Most importantly, the archaeological levels are defined by their Datation which can be broadly defined with main historical periods or related sub-periods restricted by their *terminus post quem* and *terminus ante quem* years. Further, precise years can be entered separately.

The database was built using open-source PostgreSQL/PostGIS RDBMS on a VPS Linux Debian 7.0 provided by SRCE. The data is accessed and manipulated within open-source desktop-based software QGIS while viewing and basic queries are also possible within Quantum GIS Web Client. Accessing the data is protected, so the indicated distributed aspect could be the prospective dissemination asset.[7]

Limits to the reconstruction of Rab's first urbanscape

Lack of systematic excavations, grey literature and lack of collected finds represent a problem for researchers studying the early urbanism of Rab. The major reshaping of the historic urban tissue, at that time in a severely ruined state,[8] took place at the end of the 19th and within the first half of the 20th c. with the onset of tourism and some major construction undertakings within the town walls or in the immediate vicinity.[9] Apart from scarce photographic documentation, the only records of potential features discovered are rare mentions, mostly within pseudo-historic sources.[10] The few professional reports on the main monuments and features also date to this period,[11] often remaining the only source for the study of the ancient town to this day.

Any archaeological and historical reconstruction of the town's ancient and medieval grid is biased by these shortcomings, also evident in earlier works. From V. Brusić who tackled the problem from his viewpoint in the 1920s to the most recent literature studying the ancient town's area,[12] all scholars examined the subject mainly on the basis of the few ancient monuments still present at Rab or known to have originated there (summarised by

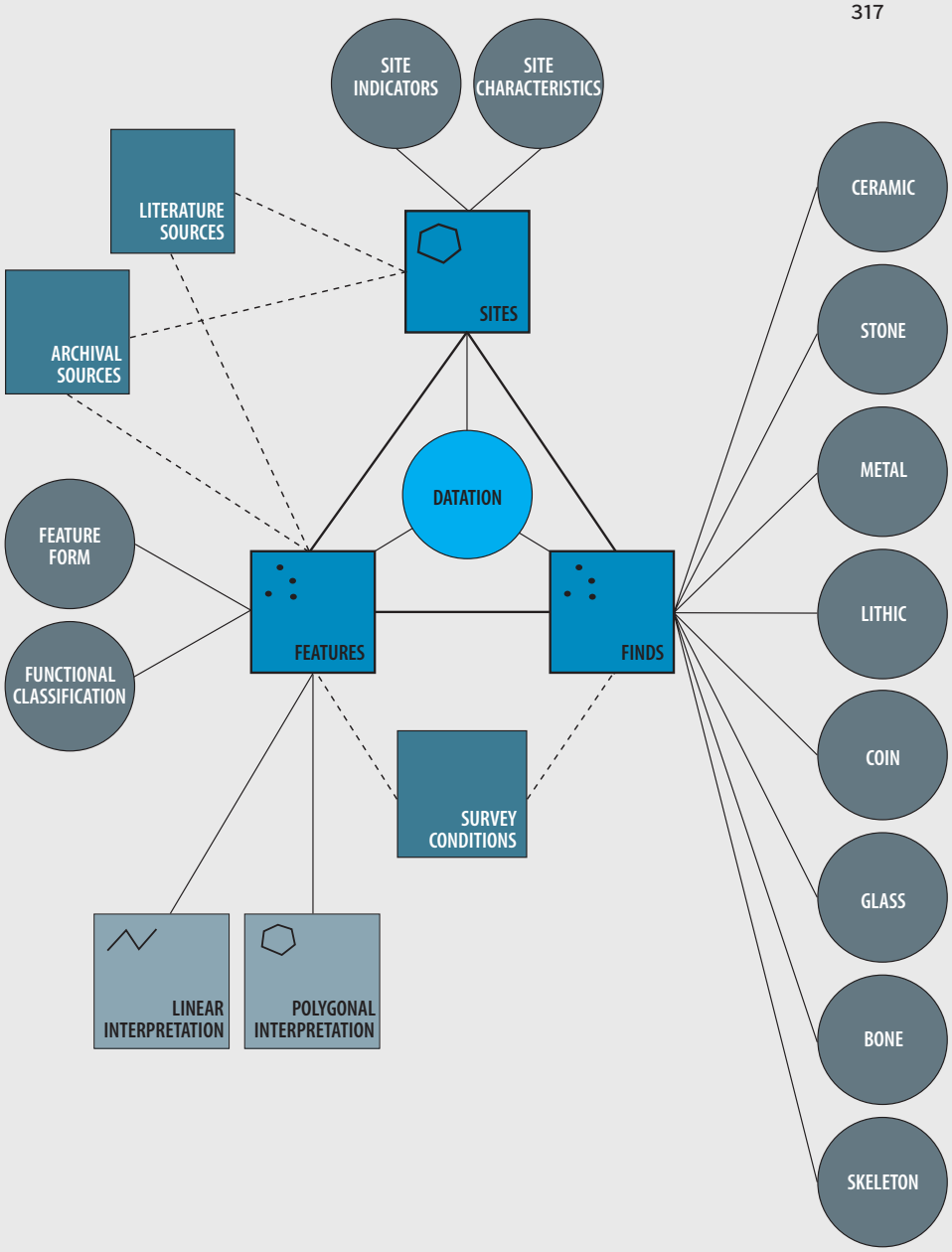

FIGURE 1
Schematic representation of the Rab database structure (drawing by N. Šegvić).

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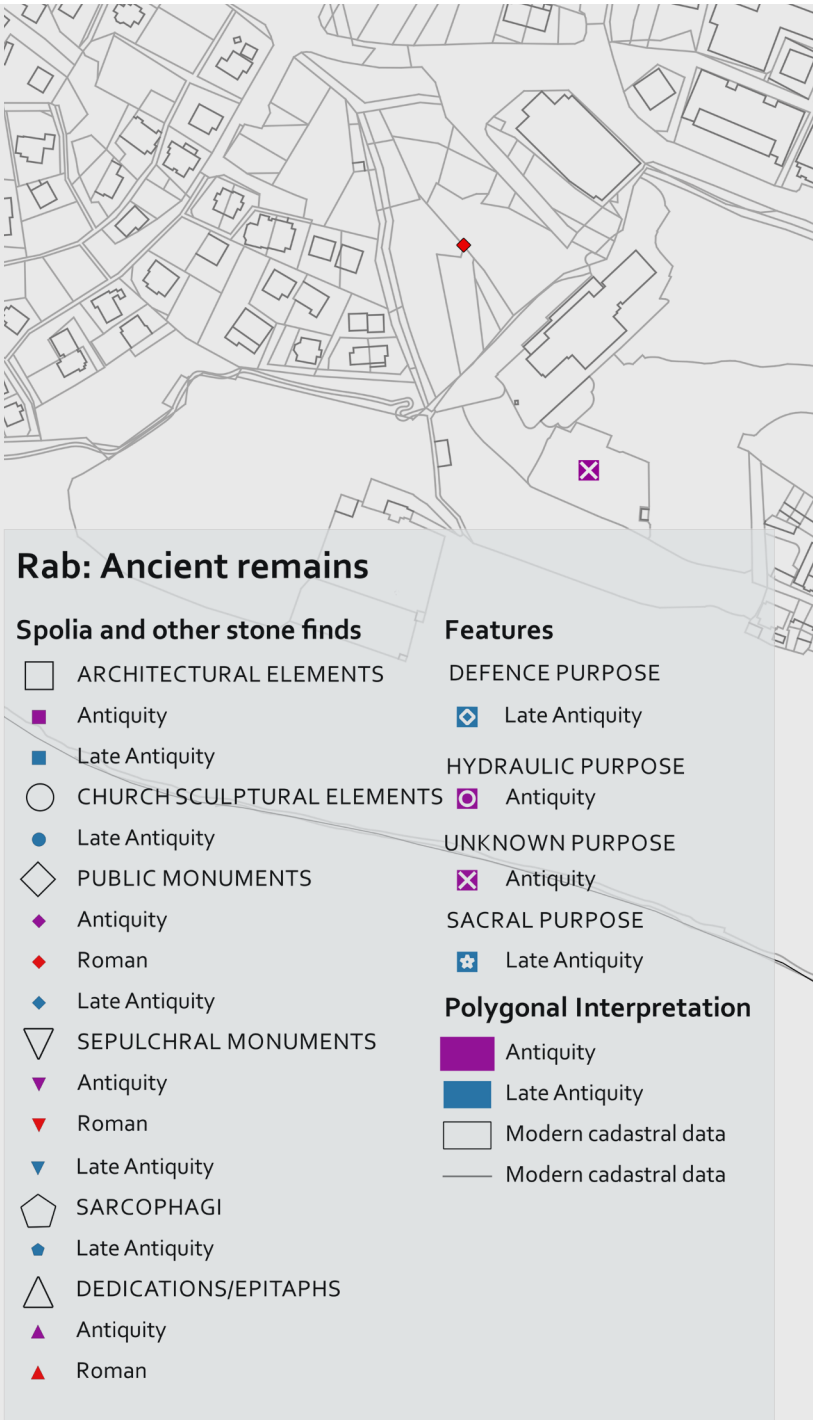

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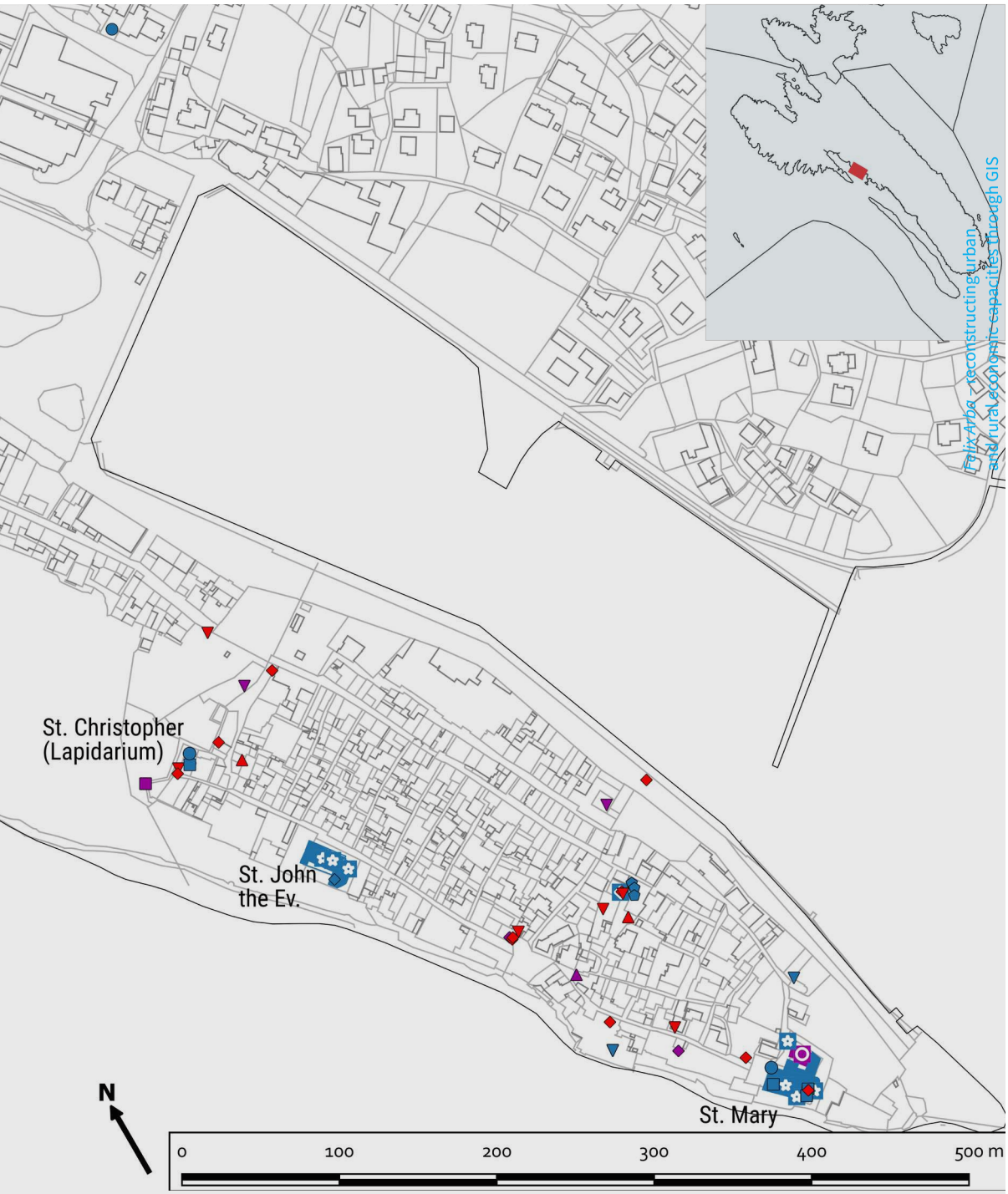
FIGURE 2

Ancient features, spolia and other stone finds within the area of modern Rab. Clustering at St. Christopher church is due to its modern function as *lapidarium* (source: Rab GIS, Basemap: DGU; drawing by N. Šegvić).


St. Christopher
(Lapidarium)
St. John
the Ev.
St. Mary
N
0
100
200
300
400
500 m

B. Nedved).[13] It resulted in discussions limited to identifying the area occupied by the ancient town as opposed to that of the late medieval one, mainly based on stone monuments – *spolia* (FIG. 2).

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Spatial distribution of finds (FIG. 2) is rather a proof of their post-classical value as a building material, reuse of decorative features and as collectables, as they are usually understood.[14] Although some of these monuments hold value for identifying structural and decorative features of the ancient town, the lack of spatial certainty hinders possibilities to locate them with any accuracy.

Building a coherent ancient reconstruction on inconclusive data is debatable. Hence it is important to preserve this aspect in the database reflecting different scales of spatial certainty and distinguishing features known only from historical/archival sources. Whenever possible, the finds were placed in their first known location, while their current location was preserved as an attribute in terms of the depository. Obviously, if *spolia* still exist in their current location, they were given the appropriate spatial reference and marked as *in situ*, the evident dilemma remaining their authentic position. Lastly, finds mentioned in the sources, but today lost, were put in their referred location but marked as supposed existence. In this way, these finds can still tell some of the town's history, if one takes into account aspects other than the precise date and spatial location.

Aoristic analysis: merging the gap between rural and urban histories

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Having dealt with the spatial uncertainty issues in the city, accounting for diverse temporal scales, also prominent in the data, required a different approach. Sources of the analysed data (FIG. 3) are extensive field surveys, literature and archival sources. As such, a well-defined archaeological context and precise dating are usually unknown. These circumstances pose difficulties for analysis of spatio-temporal patterns possibly hidden in the data. The issue is inherent in archaeological research and should not be disregarded in analysis and visualisation. Furthermore, as few precisely dated finds and structures do exist, there is a need to preserve and visually emphasise the presence of different temporal scales. Aoristic analysis, defined by Ratcliffe,[15] refers to similar problems in crime mapping. The method was first applied to archaeological data by Johnson[16] and few times since[17] while Wilson[18] applied similar probability calculations to economic proxies.

Aoristic analysis identifies the probable time of events which certainly occurred within known temporal parameters, but whose exact time is unknown. Specifically, architectural structures, epigraphic monuments or sculptures, which echo the expected construction events, can only be determined with their *terminus post quem* (TPQ) and *terminus ante quem*

FIGURE 3
Tables showing type, function and datation of finds (upper table) and features (lower table) included in aoristic analysis (drawing by N. Šegvić).

Type of finds	Purpose	Datation
Sarcophagus	Sepulchral monument	Antiquity
Cipus		
Tombstone		
Roman altar		
Dedication /Epitaph inscription		
Stone inscription	Public monument	Antiquity/Late Antiquity
Sculpture /Sculptural element	Public/private monument	Antiquity/Late Antiquity /Early Middle Age
Epigraphic monument (statue base)	Public/private monument	Antiquity/Late Antiquity
Pluteus	Church sculptural element /Architectural elements	Late Antiquity /Early Middle Age
Ciborium		
Transenna		
Architrave (altar screen)		
Column fragment (capital, pilaster)		
Architectural element	Unknown	Antiquity/Late Antiquity /Early Middle Age

Type of features	Purpose	Datation
Grave	Funerary	Antiquity
Pottery kiln /Pottery kiln indication	Manufacture	Antiquity
Mosaic	Church decoration	Late Antiquity
Fortification wall	Defence	Late Antiquity /Early Middle Age
Defence moat		
Fortification tower		
Church	Sacral	Late Antiquity /Early Middle Age
Monastery		
Chapel		
House/palace	Residential	Middle Age
Arcitectural feature	Unknown	Antiquity/Late Antiquity /Early Middle Age

(TAQ) delineating a time span within which the event must have occurred. The temporal query will be conditioned by the predefined time slice with a specific duration. The resulting weighting defines the probability of a certain event occurring within a certain time slice within a known time span. Thus, the aoristic weight will be given as a ratio between the temporal resolution (time slice) and the time span of the event:[19]

$$t_{es} = \Delta / (TAQ_e - TPQ_e)$$

where t represents the aoristic weight, e represents the event, s represents the time slice under consideration, and Δ represents the duration of the time slice.

To apply aoristic analysis on the selected data, several assumptions had to be imposed on the archaeological record under examination:[20]

- construction time must be considered as a singular occurrence
- the construction event in question occurred only once which gives every event a value of 1.0 adjusted by the aoristic weight reflecting the probability of the event happening within a time slice
- construction events are considered as independent, i.e. it is assumed that one construction event would not stimulate another spatio-temporally correlated event
- the probability distribution of construction events throughout the examined time span is uniform
- time slices must be of equal duration for all queries
- the events with a time span shorter than the predetermined time slice have to be rounded up to the temporal resolution of the time slice.

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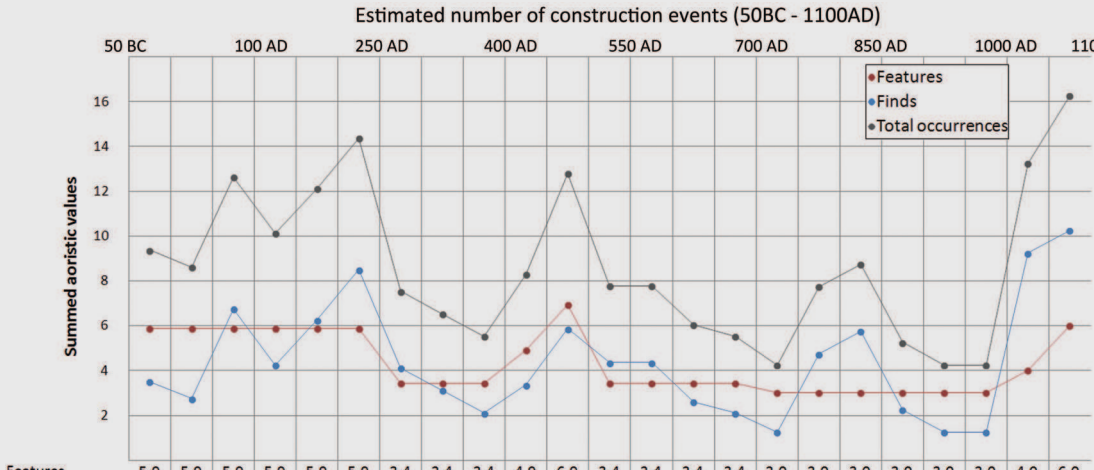
According to these hypotheses, the data (FIG. 3) were considered as presumed evidences of construction, craft or artistic activity: architectural remains such as residential, sacral or fortification architecture, manufacturing remains, stone inscriptions echoing construction events,[21] public or private sculptures reflecting adornment, and church sculptural elements and mosaics indicating decoration or redecoration of churches. Arguably, the progress of society might also be evaluated through the existence of sepulchral monuments or sepulchral remains indicating a certain expenditure and allocation of resources, though on a private and small-scale level. These activities might be seen as a result of increased economic capacities for such projects regardless of their scale or origin. The scope of the investments ranges from small scale to large scale while their origin might be seen in the public or private sphere. The act of completion of these projects can be seen as a temporally unique event be it a result of construction, craft or artistic activity.



Features	5,9	5,9	5,9	5,9	5,9	5,9	3,4	3,4	3,4	4,9	6,9	3,4	3,4	3,4	3,4	3,0	3,0	3,0	3,0	3,0	3,0	4,0	6,0
Finds	3,5	2,7	6,7	4,2	6,2	8,5	4,1	3,1	2,1	3,3	5,8	4,3	4,3	2,6	2,1	1,2	4,7	5,7	2,2	1,2	1,2	9,2	10,2
Total occurrences	9,4	8,6	12,6	10,1	12,1	14,4	7,5	6,5	5,5	8,3	12,8	7,8	7,8	6,0	5,5	4,3	7,8	8,8	5,3	4,3	4,3	13,3	16,3

FIGURE 4

Graph showing the accumulated aoristic values for architectural remains (red line) and stone finds (blue line) dated from Antiquity to the early Middle Ages.
The total sum of all values (gray line) gives the number of probable construction events on the island.

The timeline and temporal weighting reflect the datation of the main diachronic periods and sub-periods on Kvarner: Antiquity (50BC-700AD), Roman period (50BC-250AD), Late Antiquity (250AD-700AD), Early Middle Ages (700AD-110AD) (source: Rab GIS, Basemap: DGU; drawing by N. Šegvić).

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The results (FIG. 4) give the temporal distribution of the events, based on probability weighting, while the area defined by the graph can be regarded as an indication of the magnitude[22] of construction events. Specifically, the graph indicates the probability of construction activity occurrences from Antiquity to early Medieval time on the island while the Y axis gives the sum of the construction events ascribed to a certain time slice given their probability of occurrence.

The following conclusions can be derived from the graph:

- the majority of features could have been dated only to broad time spans. Hence, the accumulated aoristic values generate a generally stable line
- stone finds (epigraphic and sculptural monuments) echoing a construction activity can be dated more precisely. Accordingly, the resulting accumulated aoristic values show greater variability over time
- increases in construction activity, judging from the architectural remains, can be observed in 5th c., henceforth P-2, and from 1000 AD onwards, henceforth P-4. The former increase can be considered as a peak in an otherwise stable probability of construction events
- P-2 is also evident in stone finds
- the aoristic values of stone finds show a substantial increase from 1000 to 1050 AD which continues onward on a smaller scale
- stone finds show two peaks in Antiquity: one in the first half of the 1st c. and the second from the first half of the 2nd c. to the first half of the 3rd c. As the time span shows an increase in relation to previous years, it will be referred to as P-1
- stone finds show an increase in second half of the 8th to the first half of the 9th c., henceforth referred to as P-3
- the aforementioned peaks are followed by decreases in the activities on the island

Interpretations and inputs for future research

In an attempt to overcome the imperfections of the data collected through survey and written sources, we have exploited the advantages of GIS and the complex database developed for data recording and analysis. Apart from demonstrating economic potentials and time frames for the major construction waves in the town and on the island within the 1st millennium AD, we have shown how data lacking precise spatio-temporal attributes can still be useful for historical reconstruction.

Indirectly, these results offer a better understanding of certain problems tackled by previous scholarship and shortly outlined before. As the graph and maps show, the intense activity can be allocated to the first centuries

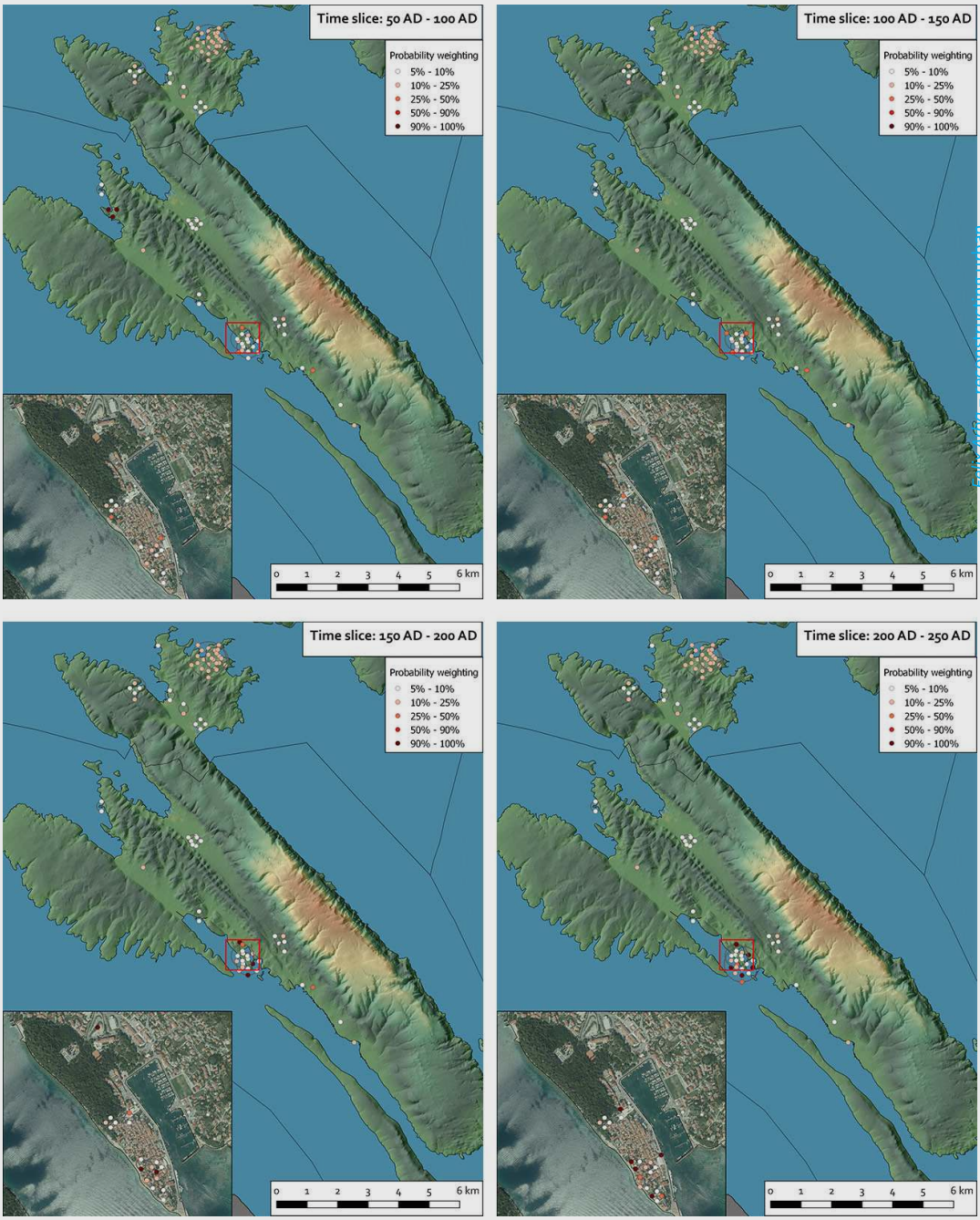

FIGURE 5

Spatial distribution of finds and features reflecting P-1 in the graph on Fig. 5 (source: Rab GIS, Basemap: DGU; drawing by N. Šegvić).

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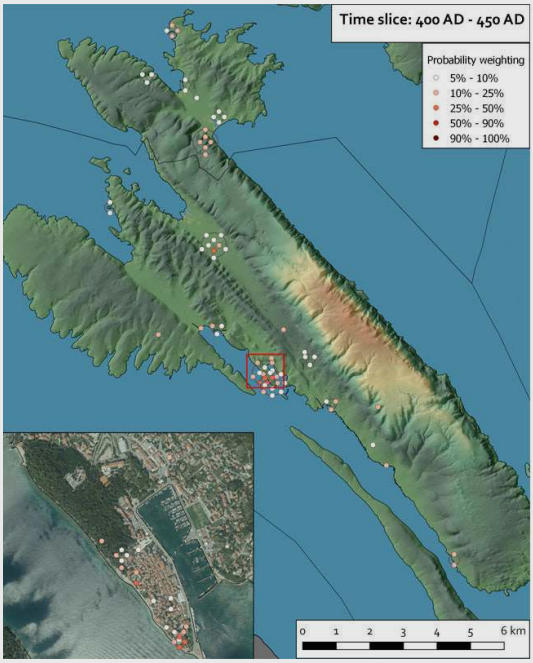
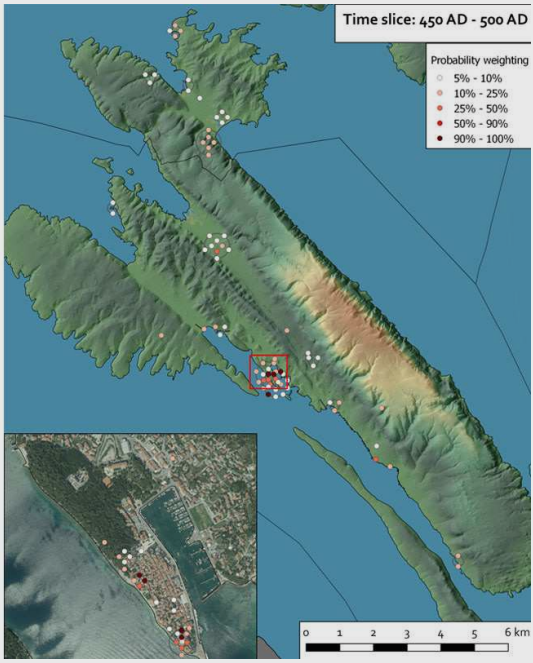
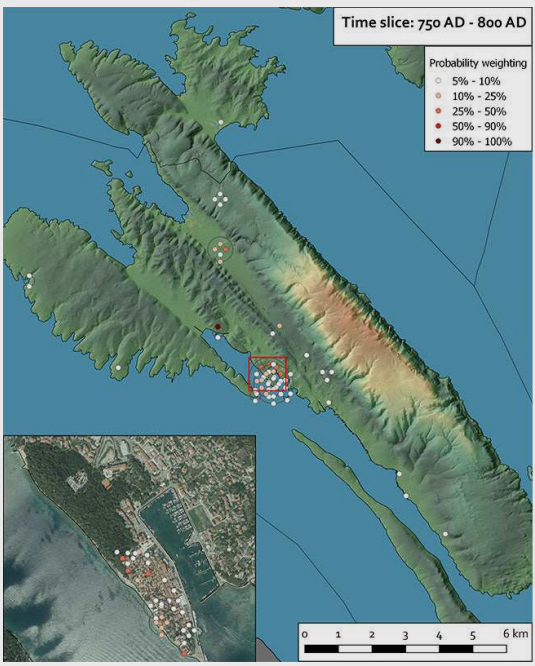
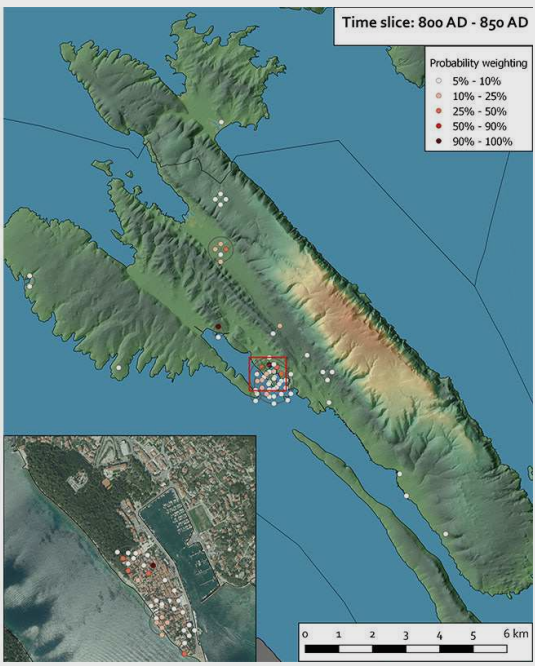

Time slice: 400 AD - 450 AD
Probability weighting
5% - 10%
10% - 25%
25% - 50%
50% - 90%
90% - 100%
0 1 2 3 4 5 6 km


Time slice: 450 AD - 500 AD
Probability weighting
5% - 10%
10% - 25%
25% - 50%
50% - 90%
90% - 100%
0 1 2 3 4 5 6 km


Time slice: 750 AD - 800 AD
Probability weighting
5% - 10%
10% - 25%
25% - 50%
50% - 90%
90% - 100%
0 1 2 3 4 5 6 km


Time slice: 800 AD - 850 AD
Probability weighting
5% - 10%
10% - 25%
25% - 50%
50% - 90%
90% - 100%
0 1 2 3 4 5 6 km

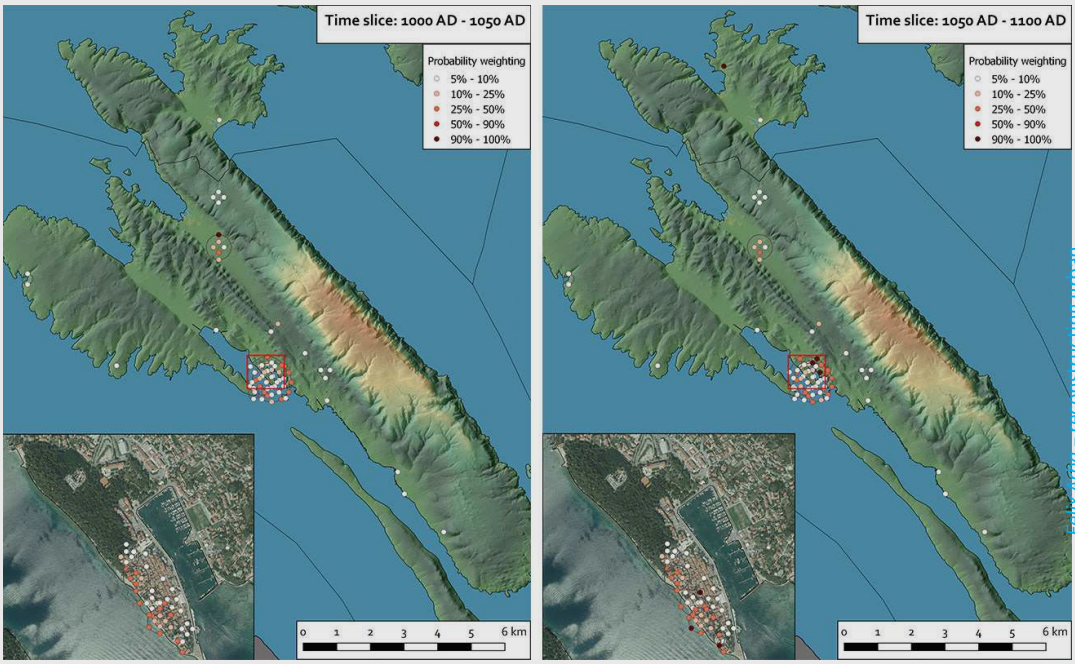


FIGURE 6
Spatial distribution of finds and features reflecting P-2 in the graph on Fig. 5 (source: Rab GIS, Basemap: DGU; drawing by N. Šegvić).

FIGURE 7
Spatial distribution of finds and features reflecting P-3 in the graph on Fig. 5 (source: Rab GIS, Basemap: DGU; drawing by N. Šegvić).

FIGURE 8
Spatial distribution of finds and features reflecting P-4 in the graph on Fig. 5 (source: Rab GIS, Basemap: DGU; drawing by N. Šegvić).

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AD (P-1, FIG. 5), mostly due to finds datable to this period. These are indicators of the shaping of the first urban reality on the island, and, while still ephemeral and spatially ambiguous, this analysis suggests conditions must have been favourable for construction, artistic or craft activity. Most notably, this activity, which had major repercussions within the town, where it peaks through a series of dedicatory monuments of Severan date,[23] affected rural locations on the island as well. A clear connection between rural and urban can now be traced on the basis of inscriptions pointing to Roman island's elite families [24] and as an indication of their wealth generated from the rural resources exploitation. In fact, survey data has shown a vibrant rural landscape in flysh fields, with surface finds of later-Roman datation, and rare stratigraphic data,[25] in all but one case,[26] indicating these notions.

The following centuries show a stable occupation of the previously located sites, with a new peak in Late Antiquity (P-2, FIG. 6), now given by a clearer combination of finds and features, parts of which are probably due to the erection of many sacral urban and rural complexes which are, for now, sole indicators of the island's economic capacity.[27] The following, early Medieval (P-3, FIG. 7) and Medieval peaks (P-4, FIG. 8) are again signs of intense sacral renovation.

On the urban level, no private or communal building activity can, so far, be linked to the early middle ages (biased by the lack of excavations), while the building activity on the island regains their previously level only in 11th-12th c. (again evidenced only in ecclesiastic buildings),[28] which agrees with the town's development as proposed by R. Ivančević.[29] The author, in fact, in his view of the development of Rab took into account a wider comparative approach, spanning the entire Adriatic, but having a close analogy at Osor and postulated an ever-changing urban tissue which could fluctuate following diverse societal needs, and ultimately displaying its economic possibilities. Rare finds seem to point in this direction as well; in this period, we can then imagine the limits between town and *suburbium* fade (burials in sarcophagi within town), while the urban tissue is shaped by new places of worship (the former Cathedral, St. John and perhaps the first church on the site of St. Justina,[30] are of early Christian foundations), emergence of empty spaces and different forms of residential architecture,[31] and with its defences being refitted to this new settlement pattern (segment of fortifications described by N. Budak[32]). It is on this, simplistically outlined Late Antique/early Medieval bases, and not those of the early Roman town, that Medieval Rab later developed.[33] This view can be further backed by the recent discoveries at *Fulfinum* (island of Krk), which demonstrate the change Late Antiquity brings to the urban composition through contraction and reclamation of urban spaces.[34] Such changes, supposedly having occurred

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at Rab as well, bringing it closer to the wider Adriatic region, where this phenomenon has been widely identified and debated in all its nuances,[35] are yet to be confirmed through excavation.

The town is thus seen as an ever-evolving organism, deriving goods from the hinterland while also acting as a factor of coherence, providing the seat for municipal institutions, and later, ecclesiastic and communal ones, but also being the place of trade and the setting where the economic status of the island's inhabitants is jointly publicly displayed. Ultimately, it seems that the development observed within the town walls can be followed throughout the island, where rural sites evolve and change, following similar patterns to those traced in the urban reality. Here, we see rural sites and their mutual relations being transformed with the building of churches (some becoming monastic settlements at a later date?)[36] which become new meeting places,[37] and the emergence of new forms of settlement (e.g. short-lived fortified sites), drawing from the same sources of sustenance as before, while maintaining a firm connection to the *civitas*.[38] It is this combination of rural and urban, that allowed *Arba* to bear the name of *Felix* and, later, to develop in a Medieval town inserted in the wider Mediterranean commercial network laid out by Venice.[39]

Lastly, since the discussion is based on the state of the Rab GIS as concluded by March 2017, the results are yet too sensitive to few precisely dated material as a result of lack of excavations. Thus, the trend lines reflect the scarce temporal knowledge which is yet far from proving general temporal activity patterns on the island. However, it does suggest the general direction in which research can be guided, confirming or rejecting these hypotheses. Introducing new, precisely dated evidence would likely increase the robustness of the model and, consequently, the understandings of the island's diachronic processes.

Without the pretence to answer persisting questions in a definitive and irrefutable manner, we hope to have shown how GIS can help us tackle not only spatial, but also temporal questions within the evolution of an urban reality, correlating it with its hinterland, seen as the source of its wealth, means of sustenance and other resources needed for it to thrive.

Notes

* This paper stems from the work carried out within the framework of the project *RED - Roman economy in Dalmatia: production, distribution and demand in the light of pottery workshops* (HRZZ, IP-11-2013-3973). The authors would like to thank all the colleagues working on Rab for sharing experiences and information, as well as for the possibility to visit their excavations.

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