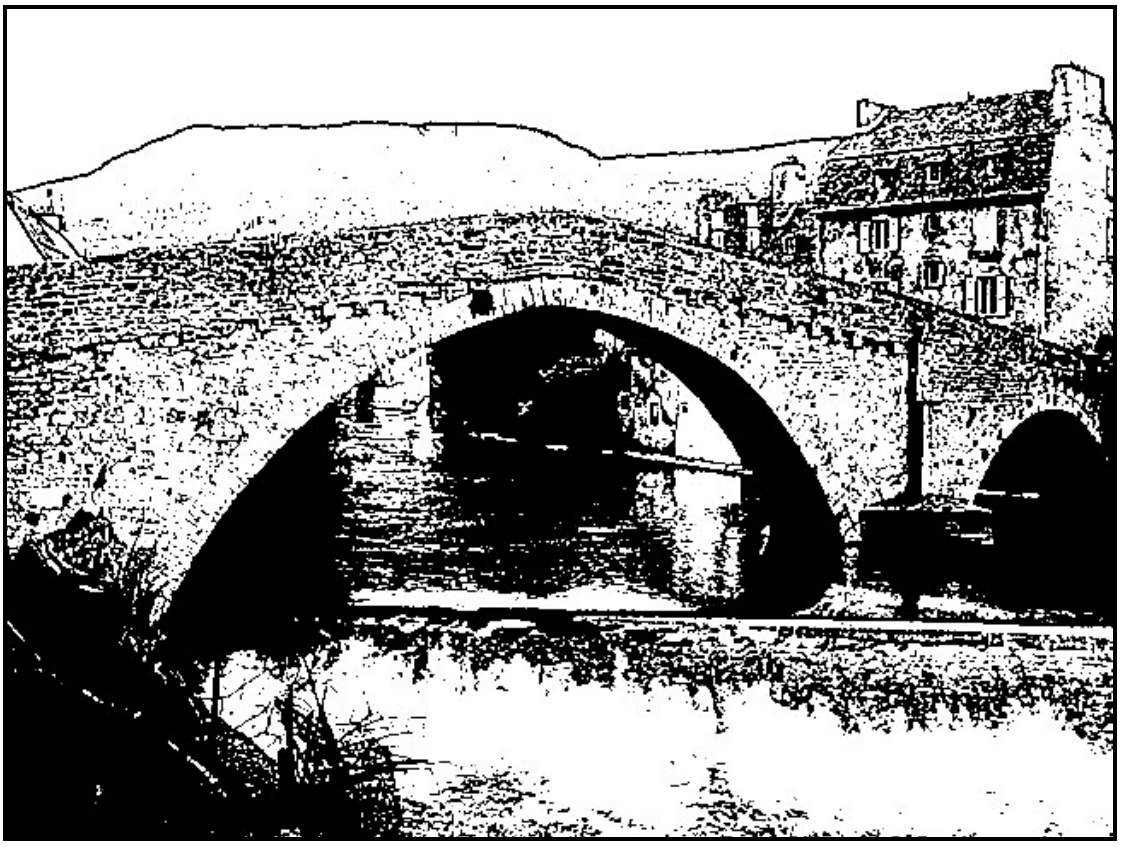
Extreme Weather: Flood Risk along Rural and Urban Sections of the River Lot



Discover Ltd.
"Timbers",
Oxted Road,
Godstone,
Surrey. RH9 8AD

www.discover.ltd.uk

EXTREME WEATHER: FLOOD RISK ALONG RURAL AND URBAN SECTIONS OF THE RIVER LOT

TEACHERS' NOTES

- River channel and floodplain morphology are investigated in this unit and used to address the issue of flood risk along the River Lot. The Lot has formed a well-developed sequence of river terraces, each with different flood risks associated with them. This unit focuses on assessing the risk of flooding along the River Lot on its journey along the northern flank of Mont Lozere to the city of Mende.

- The fieldwork for this unit is carried out between Eagle's Nest and Mende and transport is required. Students leave the coach to collect data at Le Bleymard, Bagnols-les-Bains and Mende and use a range of quantitative and qualitative techniques.

- This study gives opportunities to prepare for examinations in geographical investigations and techniques and to produce detailed, relevant case study material for hazards and flooding.

- The unit addresses the methods and limitations used to map flood risk in both rural and urban areas and students are encouraged to consider this contrast with respect to the River Lot. This gives considerable scope for concentrating on either human or physical aspects of flood risk in subsequent classroom work (or a balance of the two).

- Some groups may wish to take measurements of river channel variables and we generally advise either the Souteyran or Usclade rivers for this purpose (see alternative units). However, it may be possible to incorporate some of these measurements on upstream stretches of the Lot.

- River terraces on the Lot are evidence of sea level changes and tectonic uplift and these ideas may also be incorporated as desired.

REFERENCE TEXTS

Ministere de l'Ecologie et du Developpement Durable (2006) Atlas Des Zones Inondables Du Bassin Versant Du Lot

Digby, R., Hurst, Chapman, King, Owen (2008) *AS Geography for Edexcel*, OUP

INTRODUCTION

GENERAL INFORMATION

The Massif Central, a roughly triangular upland area covering one-sixth of France, contains a landscape of enormous variety characterised by a number of distinctive landforms. Water is an important and dynamic component of this landscape system. The striking gorges of the limestone Causses reflect the erosive power of the Massif's principal rivers. Today these waters have become a major recreational attraction and have brought an important source of revenue into the region.
Elsewhere, water plays a vital role in agricultural activity and many rural valley communities rely upon the flow of rivers for their continued prosperity. The dynamic nature of the river system has a direct impact on man. Heavy rain in October 1987, September 1994, September 2002 and December 2003 (Figure 1) brought severe flooding to many areas; the droughts of 1989 and 1990 have reduced river flow and this, together with increased deposition, has made it almost impossible for some of the canoeing and rafting businesses to operate profitably.
People also have an impact on rivers: pollution is becoming a major problem as more farmers turn to chemicals to increase yields and as domestic waste tips build up outside the major settlements. River channels have been straightened and banks protected in urban areas and in the rural sector channelisation has been used to re-direct flow onto agricultural land.

The physical geography of the Massif Central means that the region forms a vast watershed from which rivers flow to the Mediterranean, and the Atlantic coasts. These rivers are not important for navigation but their valleys provide route-ways for road and rail transport away from the mountain mass to other parts of France. The water input into these river systems comes principally from the Atlantic depressions.

The Massif is well watered. Lozère has more than 2700 km of water courses and 230,000 hectares of forest land – it constitutes “Water Tower” and green lungs of Languedoc-Rousillion to which it belongs. Precipitation is high with more than 1,200 mm per annum being recorded in the highest areas. The whole of the Massif has more than 75 days of frost each year and large areas of ground are snow covered for more than two months of the year, rising to six months in the high mountains. The prevailing soil and geological conditions favour rapid run-off and overland flow tends to be the dominant process during periods of heavy rain (See Figure 2). This is accentuated where deforestation has occurred on a large scale. There are many natural and artificial water stores that may help to regulate river-flow, such as *Lac Villefort* at Villefort and the *Reservoir de Cambous* between Florac and Alès. These are used for the supply of water to surrounding towns and for recreational purposes.

River management is an important aspect of water control and conservation in the Massif. Much of the management in the Cévennes is entrusted to the National Park, which is primarily responsible for maintaining the landscape. Elsewhere Regional River Authorities have implemented various river management schemes. Good management can only be achieved by gaining a full understanding of the physical processes acting within river channels - the processes at work today, the erosional history, and the physical controls of the environment.
Although total yearly precipitation is high in the region, it is as always distribution that is the problem. During the long, dry summer, water supply may be barely sufficient to meet demand. With an ever-increasing number of tourists in the region, the problem is becoming more acute. The Departement of Lozère has become sufficiently concerned to fund research by the University of Alès into the hydrology of the region. It is hoped that a more efficient way of managing the available water will be found.

SPECIFIC INFORMATION

The Lot valley lies along the northern slopes of Mont Lozère. The route from Eagle's Nest follows the Usclade, a tributary of the Lot, into Le Bleymard and then the Lot from Le Bleymard to Mende. The headwaters of the Lot (Usclade) drain a schist and granite area, while limestone prevails downstream. The whole Lot basin covers 12,000 km^2, but only 1340 km^2 is located within the department of Lozere. The two main sources of extreme weather, in terms of precipitation, are Atlantic depressions (mainly December-April) and frontal rainfall from Cevenol storms. The Lot catchment is of predominantly rural land use (45% woodland, 54% farming) and only 1% is urban (mainly Mende, Marvejols and Saint Chely d'Apcher). Human activities include abstraction for water supply, small hydroelectric plants and diversion for irrigation, but impacts are greater during periods of low flow, not flood events.

Devastating floods affected the region in 1994 and 2002. Since then, the neighbouring department of Gard has been proactive in developing a comprehensive policy on flood prevention, which aims to 1) adapt land use, 2) improve information during a crisis, 3) prepare for extreme events, 4) raise awareness and educate about risks and finally 5) to focus on retention of water and reduction of flow speeds during a flood. They include a web link to www.vigicrues.ecologie.gouv.fr, a real-time map of flood risk for the whole of France. The department of Lozere has also made progress in managing flood risk and its rivers are included in a detailed map of flood zones, developed by DIREN Languedoc-Roussillon. There are 22 hydrometric stations in the drainage basin.

Discharge, precipitation and temperature data have been collected daily, from a site close to the Eagles Nest, since December 1997. This data is available at the Centre or from our Web pages.

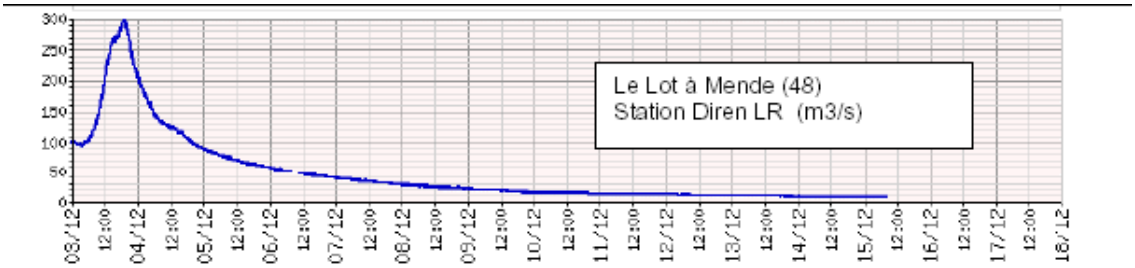


Figure 1: Discharge of the River Lot in Mende during the flood event of 3-5 December 2003.

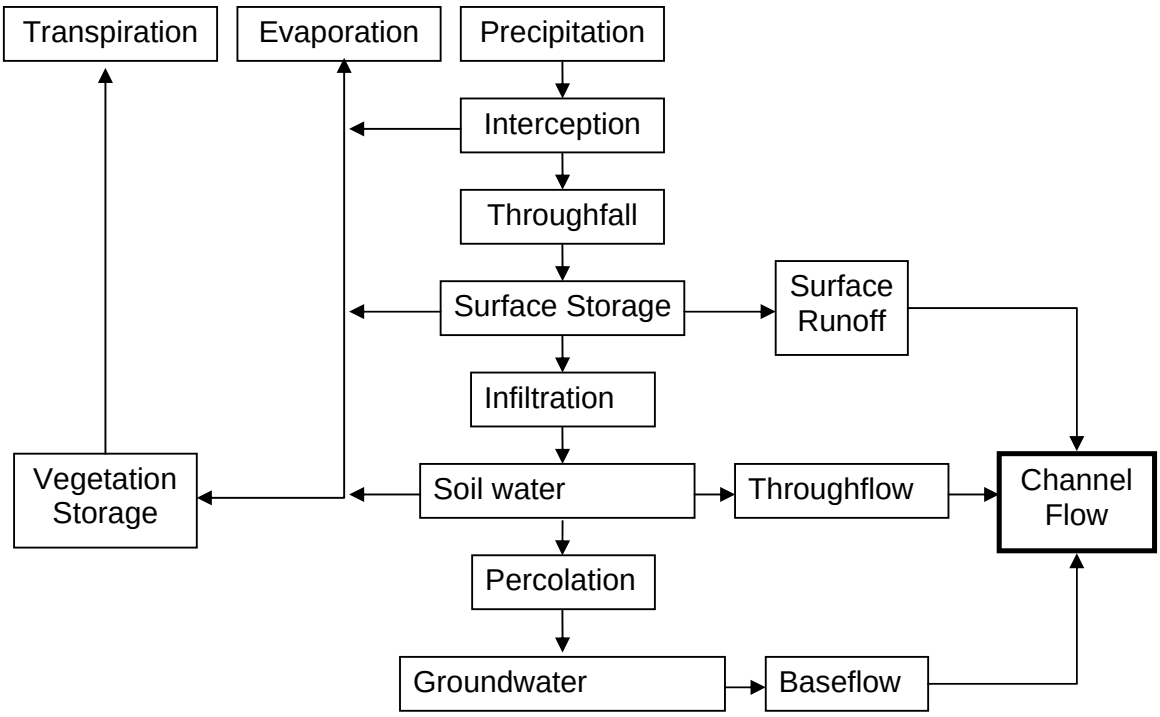
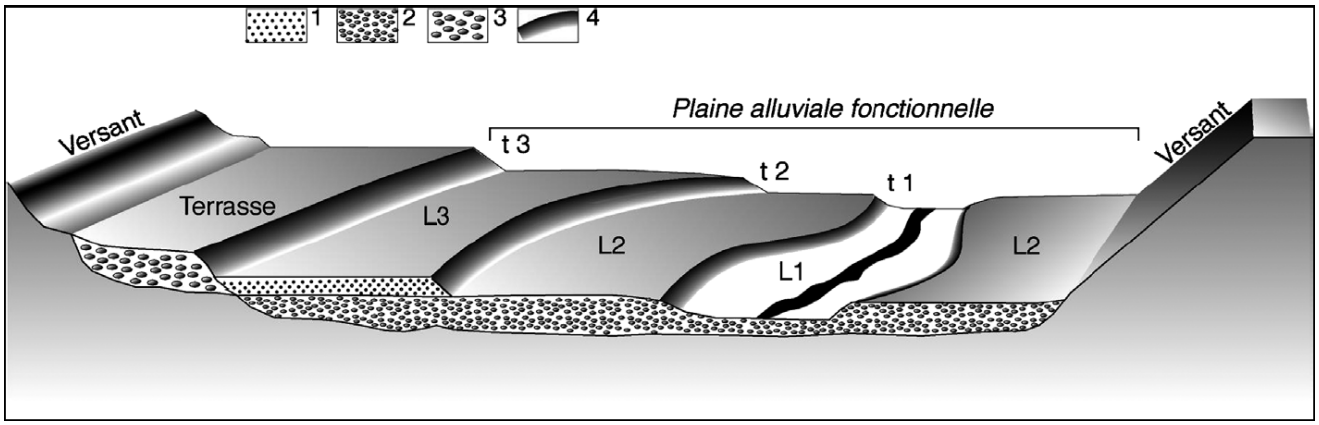


Figure 2: The drainage basin system

Figure 3: Schematic diagram of a river terrace system



AIMS

1. To investigate flood risk in a rural area and to account for variations across the floodplain.
2. To investigate flood risk in an urban area and to assess potential impacts on the human environment.
3. To compare and contrast the techniques used to measure flood risk and the degree of flood risk in rural and urban areas.

OBJECTIVES

1. To assess rural flood risk by analysis of the river terrace sequence upstream of Le Bleymard.
2. To rapidly assess rural flood risk in Bagnol-les-Bains.
3. To complete a comprehensive survey of flood risk in Mende, using a combination of primary data and historical records.

HYPOTHESES

1. The river Lot contains a series of well-defined terraces.
2. The terraces of the river Lot have different levels of flood risk associated with them.
3. Some areas of the city of Mende are affected by the risk of flooding.
4. The total risk of flooding in Mende varies geographically due to differences in the potential for flooding and the land-use value.

DATA COLLECTION SITES

The three main sites for data collection are the Usclade river near Le Bleymard, Bagnols-les-Bains and Mende. The Mende study is the most comprehensive, so good time should be allowed for orientation and data collection here. Some parts of this unit could be combined with river processes/downstream variables work on the Usclade (see alternative unit).

EQUIPMENT

- Ranging Poles
- Tape Measure
- Clinometers
- Trowel
- Small sample bags
- Laminated sheet of flood photos

METHOD AND ORGANISATION OF STUDY

TASK ONE – RIVER TERRACE MAPPING

As a result of sea level changes (related to tectonic uplift), the Lot valley contains a series of river terraces, which are apparent upstream of Le Bleymard. These can be traced as a series of steps and platforms extending from the valley sides. This task involves measuring the height and width of the terraces along a transect perpendicular to the flow of the River Lot. This information can then be used in the follow-up session to produce a valley cross-section and to relate different terraces to different flood recurrence intervals. The procedure reflects the method used in the official flood zone map for this area.

Equipment: Ranging pole, tape measure, clinometer, trowel

METHOD

1. Valley Cross-section

- Start measuring the valley cross-section from the top of the (wetted) near bank of the River Lot. Place the first ranging pole here.
- Walk away from the river bank (at 90° to the flow of the river) with the tape measure until you reach a significant break in the slope (a point at which the gradient changes). Place the second ranging pole here.
- Measure and record both the distance, and using the clinometer, the gradient between the two ranging poles.
- Unless the river is at bankfull, the first measurement should be of the section of the bank above the level of the water. Repeat for intervals between every break of slope as you walk away from the river.

2. Soil texture (can be done as a group)

- Use the trowel to take a soil sample from each of the terraces (relatively flat sections between steeper sections of the floodplain). Try not to take the sample from too far below the ground surface.
- Do a 'dirty hands test' to determine the texture of the soil sample.
- Also record the abundance of gravel-sized particles (>2 mm) in the soil (this is the next largest size of sediment after sand).

TASK TWO – RAPID ASSESSMENT OF FLOOD RISK

Bagnols-les-Bains has a population of 243 and has acquired some characteristics associated with a tourist centre. This settlement is visited for a short time to show students some of the challenges of identifying flood zones and risks in areas with an urbanised valley floor and a managed river channel. This will prepare students for a more rigorous assessment of an urban flood risk in Mende.

Equipment: Clipboard, recording sheet

METHOD

1. Annotated map of flood risk
    - Use the base map of Bagnols-les-Bains to locate yourself as you walk around the village.
    - Observe the level of flood risk in the village as you walk around and use your base map to make brief notes/annotations. Which areas are particularly prone to flooding? Can you identify any river terraces in the built environment? Annotate your base map with land-uses that, in your mind, are at risk during an extreme flood event. Also add notes about any ways you notice the river has been managed (e.g. culverts, bridges, channelisation).

TASK THREE – FLOOD ZONE MAPPING

Mende was built on the banks of the River Lot and has a history of flood problems, most recently in 1994 and 2003. This task first considers risk of flooding, by identifying significant changes in land elevation along pre-determined walking routes. These can later be used to plot the main terraces and slope breaks on a base map of Mende, akin to basic isolines. The task then goes on to consider potential impacts on the built environment of Mende should a flood occur, by mapping land-use values. Photographs of the 1994 floods are taken into the field as a source of historical data and to help students visualise the areas that can potentially be flooded.

Equipment: Base map, recording sheet, laminated sheet of flood photos

METHOD

Each group will be assigned a walking route through Mende, which takes in the buildings and infrastructure closest to the River Lot. All walking routes begin at the Notre-Dame bridge and take in the sectors NW, NE, SW and SE of the bridge.

1. Slope mapping
    - Your walking route will take you along several roads towards, along and away from the Lot.
    - As you walk, record on the map (e.g. use shading) any sections of the road that slope towards from the river (it doesn't matter if you are walking uphill or downhill along these sections, record it regardless). Try to record only significant slopes (long and gentle OR short and steep).
    - Use a different method (e.g. shading of a different colour) to record any sections of the road that slope away from the river.
    - Do not use any shading on sections of road that are flat or sloping along the river (upstream or downstream).
    - Use turns in the road, junctions and road names to locate yourselves as accurately as possible on the base map.

2. Recording land-use values

    - Your walking route is also divided into grid squares
    - For each grid square observe the land uses inside and give it a category (A-E) according to the descriptions in the land use key.
    - At certain points along your walking route you will come to numbered circles on your map. Each circle marks a point from which a photo was taken of the floods in 1994. This photo is included on your photo sheet and is a valuable source of historical information for this task. Can you estimate the height of the water shown in the photograph above present flow (today's levels)?
    - While on the walking route please also record (as map annotations or on a separate sheet) any indicators of potential flood risk such as house adaptations, river channel management, flood protection, flood warnings (park-at-your-own-risk signs in some car parks) etc.

DATA PRESENTATION AND ANALYSIS

VALLEY CROSS-SECTION

- The cross-section should be drawn so that the downstream direction is into the page. Measurement of the river terraces was done on the left-hand-side of the river as one looked downstream, so this should also be the case on your figure.
- Draw a symbol on the right-hand-side of your graph paper to represent the River Lot.
- Now look at your distance readings for the sequence of terraces. You need to devise a scale so that a certain number of grid squares on your graph paper represents a certain distance in metres. The scale should allow you to fit the entire sequence within one width of graph paper.
- Now use a ruler and protractor to draw lines for each pair of distance and gradient measurements, working away from the river channel.
- You should now be able to identify distinct (gently sloping) terraces separated by steeper intervals on your figure.
- If you have drawn your figure correctly and to scale you should now be able to measure the height of each of the terraces above the top of the left bank of the river. Label these heights.
- Consider (based also on the soil samples, if these have been taken and the heights of the terraces) how likely each of the terraces is to be flooded and at what over what time interval (return period). Secondary data may also be useful.

MICRO-CONTOUR MAP

This technique can be used on the slope mapping data from Mende.

- You need to start with a base map of Mende containing all the slope mapping data (from all groups), so you may need to collate the data together first.
- A slope is denoted 'slope 1' if it is the first significant slope (sloping towards the river) reached as you move away from the River Lot. Draw a line connecting the bases of all the slope 1s.
- Draw another line connecting the tops of all the slope 1s.
- Repeat this for all the slope 2s, 3s etc.
- Remember not to include slopes angled away from the river.
- Now colour the area inside of slope 1s (on both sides of the river) one colour. Use a different colour to represent the area encompassing all the slope 1s. Use another colour for the area outside the slope 1s etc. It might be worth colouring only as far as the 10 m contour line marked on your map.

FLOOD RISK MAP OF MENDE

This technique requires that the micro-contour map has already been completed.

- The flood risk for different areas of Mende can be thought of in terms of the height above the river (likelihood of flooding) and land use value.

- Instead of colours, use different hatching to identify the different land use values A-E for each grid square.
- You now have a figure showing high flood risk (for regions with high land use values close to the river) and low flood risk (for regions with low land use values further from the river).
- Comment on the flood risk map. Which parts of Mende are most at risk? What could be done to alleviate these risks?

POINTS FOR DISCUSSION

An interesting way to interpret and conclude from the data/maps is with the use of secondary data. This is where students have the chance to work with more historical information, a valuable resource in the real world for mapping flood risk. Photographs of the 1994 floods in Mende have already been utilised. In the classroom, students can consider the major historical floods of the last 300 years using the data given in Appendix 1. They can comment on:

- The different sizes of flood that have been recorded and how frequently these have occurred.
- How likely it is that floods of this size will happen again.
- What this means for the different flood risk zones identified in Le Bleymard (the terraces) and Mende, and the land uses at risk in Bagnols-les-Bains.

Also consider:

- Problems encountered by the group in any of the mapping procedures used.
- Limitations of the study – identification of terraces, estimating heights above the river etc.

APPENDIX 1: HISTORICAL DATA FOR THE RIVER LOT

Date	Details of flood
1-3 December 2003	Flood comparable to 1994
Sept-Nov 1994	Whole of Lozere flooded, with impacts on population and infrastructure
8 Nov 1982	2.85 m high at Pont de la Planche (Mende)
21-22 Mar 1956	Significant damage in the region
16, 28 August 1899	Lot flooded upstream (Le Bleymard)
22-22 Sept 1890	4.31 m high at Pont de la Planche (Mende)
4 Jan 1875	4.51 m high at Pont de la Planche (Mende)
24 Sept 1866	5.33 m high at Pont de la Planche (Mende)
1793	Devastating flood
1745	Very large flood to levels above bridges in Mende (Berliere, New Bridge)
Sept 1722	Above bridge at Bagnols-les-Bains
1705	Devastating flood along the Lot
1669	Bridges at Mende destroyed

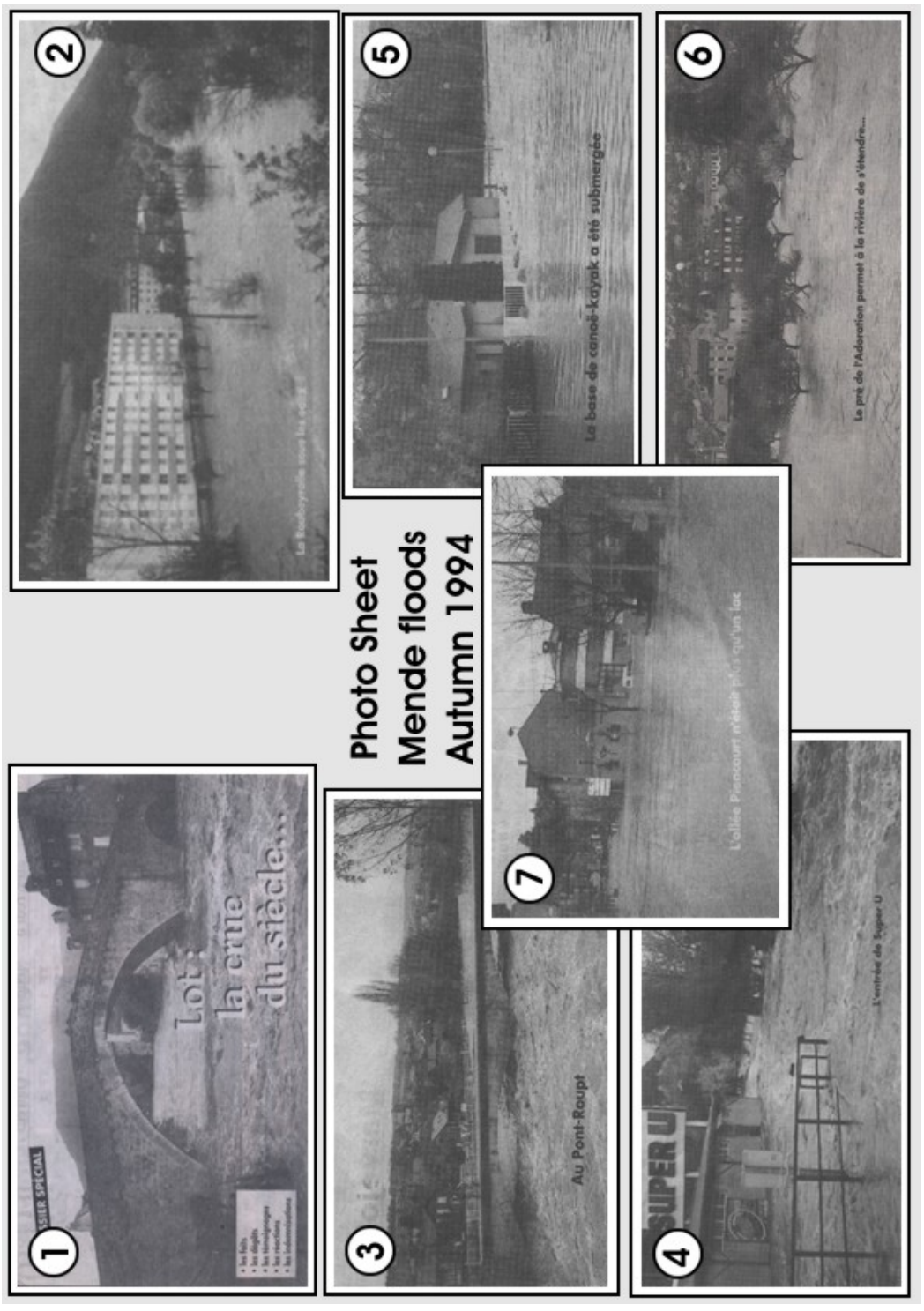
23/24 September 1994

Data	Height (m)	Discharge (m^3/s)
Lot (Roupt bridge, Mende)	4.40	>.250
Lot (Bagnols)	-	> 80

5 Nov 1994

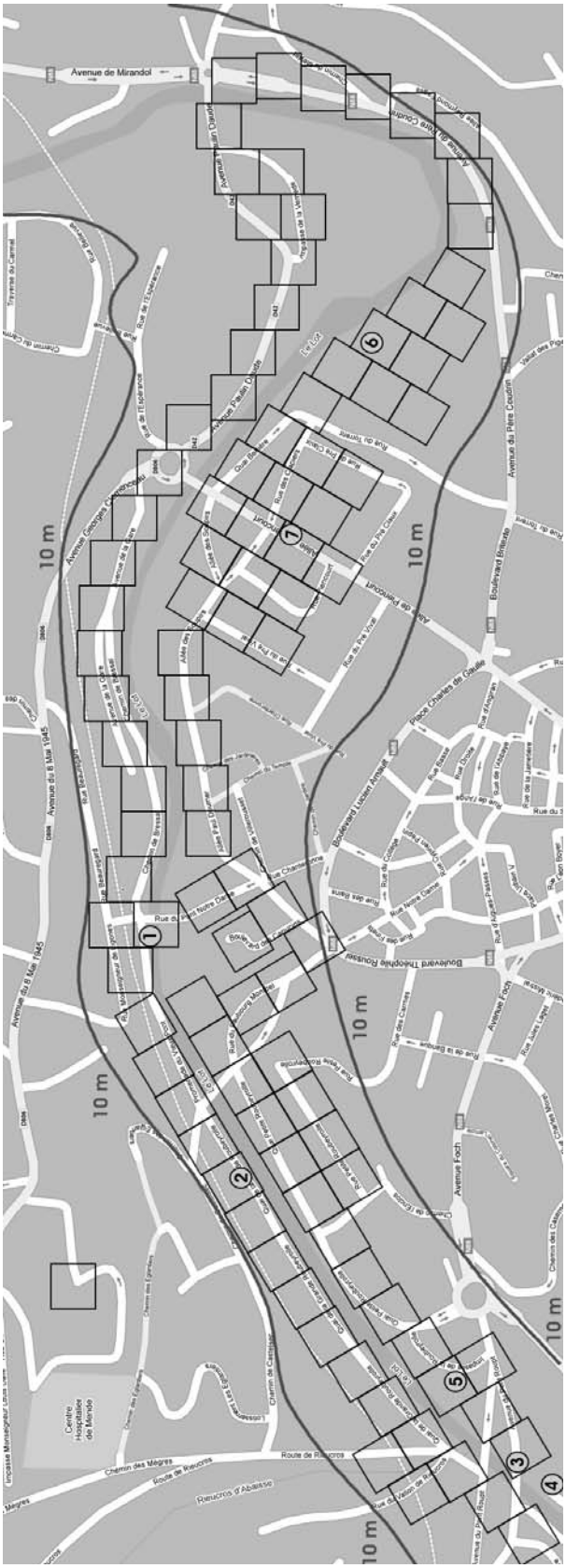
Lot (Roupt bridge, Mende)	4.60	> 300
Lot (Bagnols)	2	115

APPENDIX 2: PHOTOGRAPHS OF THE 1994 MENDE FLOOD



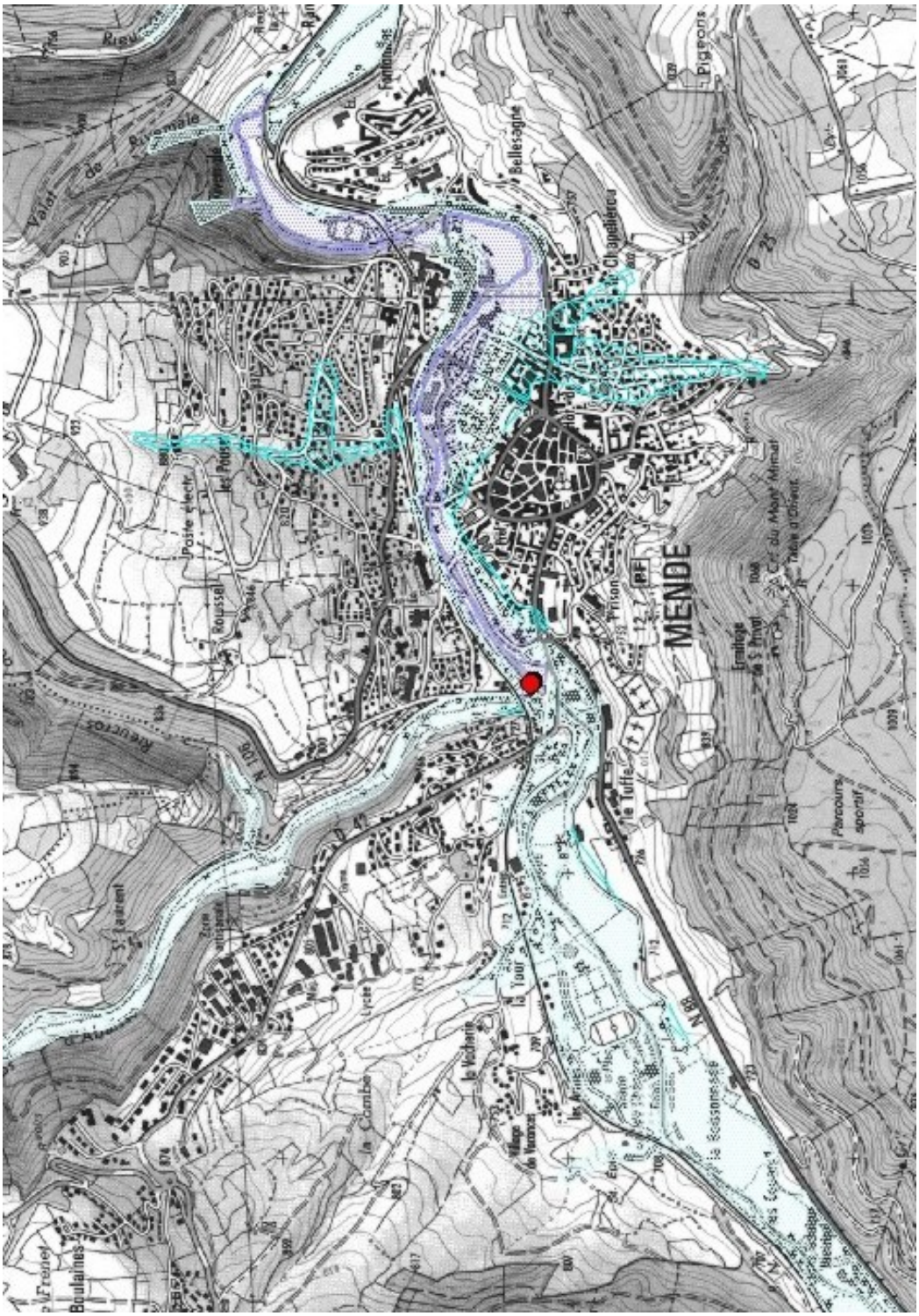
APPENDIX 3: CADASTRAL PLAN: BAGNOLS-LES-BAINS

APPENDIX IV: BASE STREET MAP OF MENDE



APPENDIX V: LAND USE KEY

Category	Value	Criteria
A	Very high	>80% of roadside bordered by commercial/residential buildings AND >50% of these buildings have 3 or more storeys
B	High	>80% of roadside bordered by commercial/residential buildings AND <50% of these buildings have 3 or more storeys
C	Moderate	50-80% of roadside bordered by commercial/residential buildings
D	Low	25-50% of roadside bordered by commercial/residential buildings. Vegetated areas predominate, such as parkland or allotments.
E	Very low	<10% of roadside bordered by commercial/residential buildings. Land vacant or dedicated to forestry or agriculture.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Fontanes
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Riou
Poste électr.
Les Pousses
Roussel
Prison
PF
Cne du Mont Mimat
Tête d'Oiset
Ermitage de S. Privat
Le Tuffe
Parcours sportif
Rieutros
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Lycée
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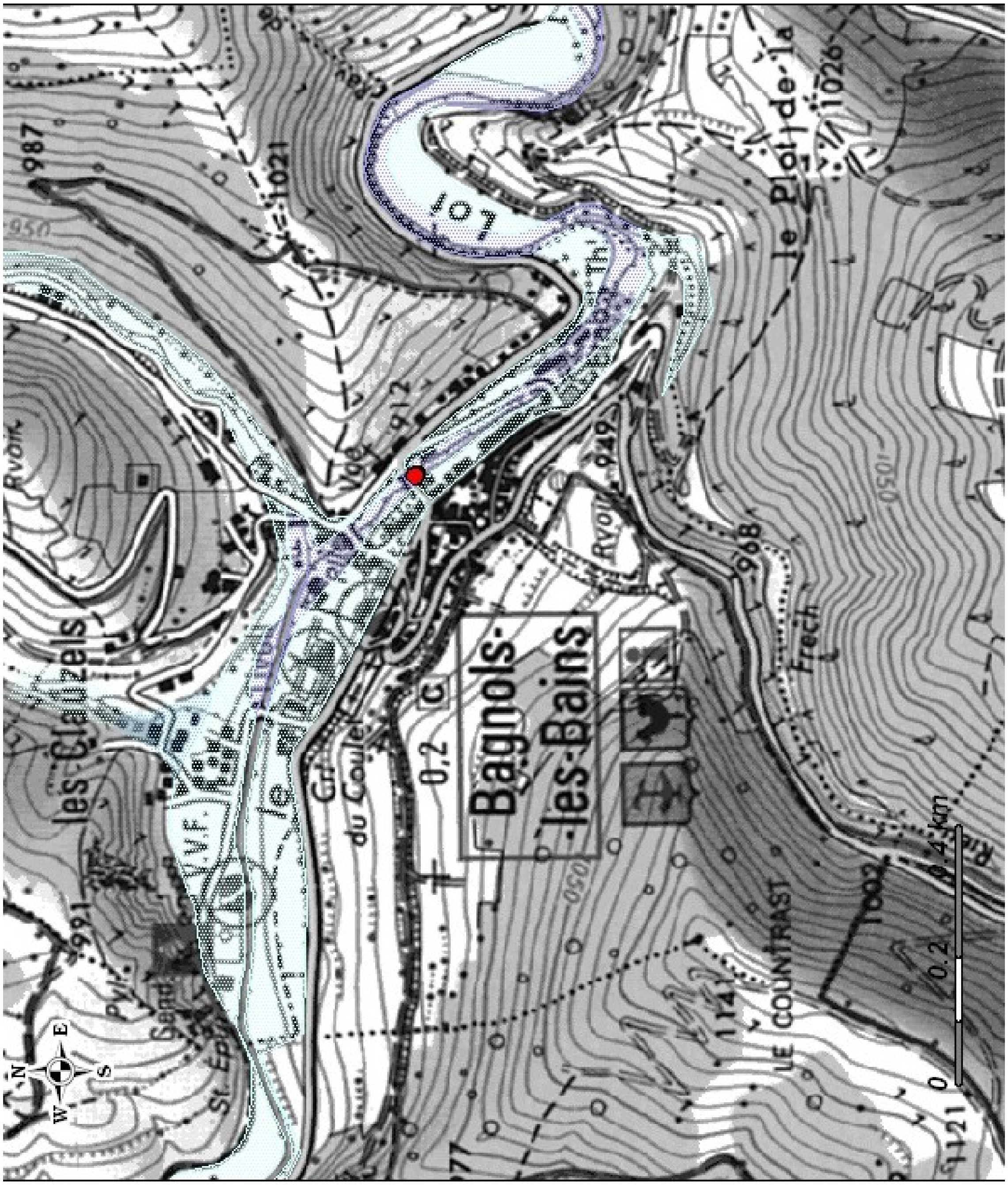
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