

*Phase 1: Diagnosis and Analysis*  
*Final Report*

**MOBILITY STUDY – PHASE II \ TRANSPORT AND  
MOBILITY STRATEGY FOR THE CONURBATION OF  
BETHLEHEM**



## MOBILITY STUDY – PHASE II \ TRANSPORT AND MOBILITY STRATEGY FOR THE CONURBATION OF BETHLEHEM

### PHASE 1: DIAGNOSIS AND ANALYSIS FINAL REPORT

#### Project data

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## LIST OF ACRONYMS AND ABBREVIATIONS

CO	Carbon Monoxide
CO <sub>2</sub>	Carbon Dioxide
CO <sub>2</sub> eq.	Carbon Dioxide Equivalent
EU	European Union
FIDIC	International Federation of Consulting Engineers
GHG	Greenhouse Gases
HC	Hydrocarbons
HTC	Higher Transport Council
MoPWH	Ministry of Public Works and Housing
MoLG	Ministry of Local Government
MoT	Ministry of Transport
NDC	Nationally Determined Contributions
NGO	Non-Governmental Organization
NMT	Non-Motorised Transport
NO <sub>x</sub>	Nitrogen Oxides
PM	Particulate Matters
PNA	Palestinian National Authority
PPP	Public Private Partnership
PT	Public Transport
RfP	Request for Proposal
SO <sub>x</sub>	Sulphur Oxides
ToR	Terms of Reference

## 1. INTRODUCTION

This report has been produced according to the Terms of Reference for this assignment, the contract no. 54/2017 signed between Bethlehem Municipality and Community Development Group “CDG” in joint venture with MOVE Mobility (signature date 29.03.2018) and according to the Technical Proposal submitted by the consortium during the Request for Proposal (RfP) stage. This report represents the final deliverable for Phase 1: Diagnosis and Analysis (final report).

This step, Phase 1: Diagnosis and Analysis builds on the previous stages of this project (Phase I: Data Collection completed in 2017 by CDG/ ARIJ and the Inception stage completed on the 30<sup>th</sup> May 2018, as part of this assignment). Achieving a thorough and in-depth understanding of the current situation related to transport and mobility issues, but also to socio-economic trends and other influential factors, is a crucial step in the mobility planning process. The analysis will provide a critical perspective on the problems, challenges but also opportunities that the transport system is facing within the study area. The results of this phase feed into the vision, scenarios and proposed measures that will be developed during the subsequent phases of this assignment. Without a sound understanding of what there is, it is impossible to provide proper advice and build suitable policies for the future. The analysis of the current situation will provide the necessary baseline against which the proposals can be measured during the implementation phase.

The overall purpose of this phase of the assignment is to understand people’s travel behaviour and (mode) choice, to understand socio-economic trends that might affect the future of mobility in the following years in the city and to understand, ultimately the challenges, bottlenecks and the solutions that are appropriate for Bethlehem. The specific objectives are:

- » Identify data availability and its quality.
- » Gather, synthesize and analyse existing data and understand the need for extra information.
- » Provide a quantitative and qualitative review of the status of important mobility and transport issues, on the following topics:
  - Institutional and financial arrangements for urban transport
  - Transport and urban planning documents, plans and strategies
  - Legal and regulatory framework for urban transport
  - Socio-economic data and trends
  - Urban form and structure
  - Regional position of Bethlehem
  - Climate change and environmental challenges
  - Road (network) characteristics
  - Public transport
  - Non-motorised transport
  - Parking
  - Road safety
  - Mobility patterns
  - Accessibility
  - Urban development trends and economic potential of the area and possible urban accelerators.
- » Highlight and provide a list of deficits, challenges and opportunities related to the topics mentioned above, in the form of a SWOT analysis matrix.

- » Develop a better understanding of what there is and what misses.
- » Prepare a baseline analysis, highlighting the most stringent problems that need to be addressed by the plan.

**Figure 1.** The sustainable mobility planning cycle. Phase: Prepare an analysis of problems and opportunities



Source: Rupprecht Consult, 2013<sup>1</sup>

The structure of the report is as follows:

- » Chapter 1 sets the scene for this report, providing general information on the purpose and structure.

<sup>1</sup> Rupprecht Consult, *GUIDELINES – Developing and Implementing a Sustainable Urban Mobility Plan* (Köln, 2013). Available at: [http://www.eltis.org/sites/default/files/guidelines-developing-and-implementing-a-sump\\_final\\_web\\_jan2014b.pdf](http://www.eltis.org/sites/default/files/guidelines-developing-and-implementing-a-sump_final_web_jan2014b.pdf)

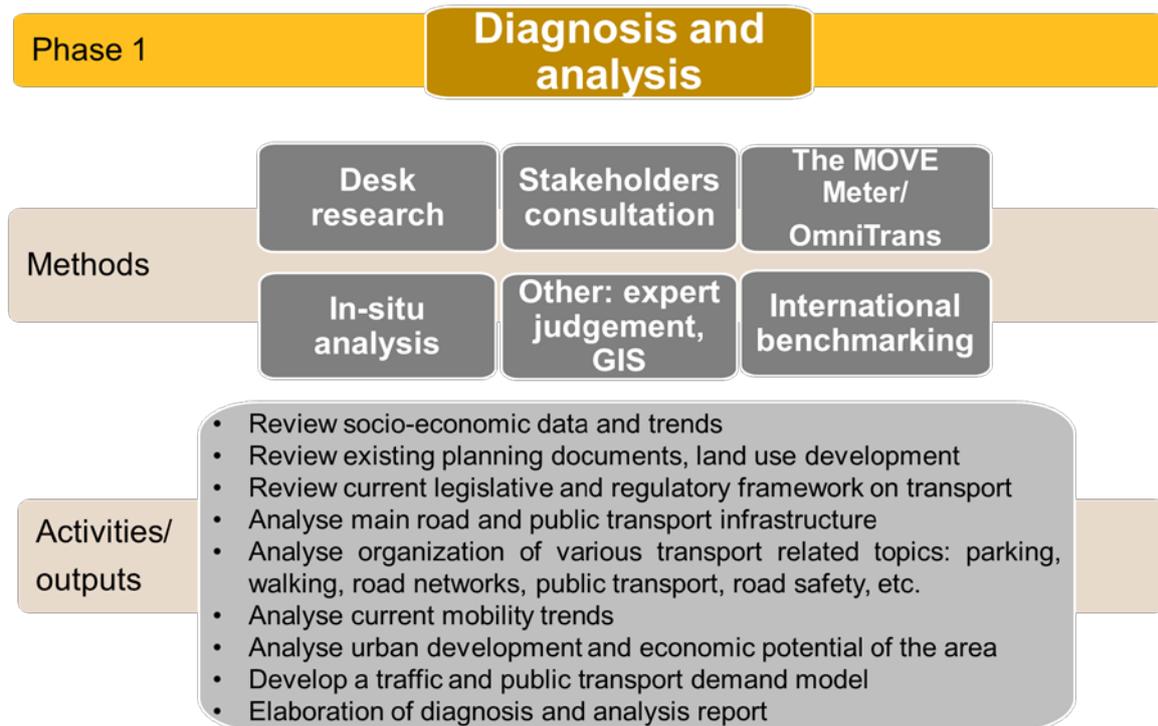
- » Chapter 2 provides an overview of the methods deployed and documents consulted to draw up the results.
- » Chapter 3 presents the findings related to various topics: law and regulations, planning policies, networks, PT, NMT, road safety, socio-economic trends, etc., based on indicators considered relevant to understanding current situation and support decision-making for future policies.
- » Chapter 4 presents a critical analysis of the findings, conclusions and a short presentation of future steps in the planning process.

## 2. METHODOLOGY

### Overview of Phase 1

Following the provision of the ToR and our technical proposal submitted during the RfP stage, for undertaking this phase of the assignment, we have used various steps and methods for deriving the results.

*Figure 2. Phase 1 summary\**



### Guiding principles and tasks

As stated in the Inception Report of this assignment, our guiding principle while developing the Mobility Study will be based on achieving a sustainable urban transport system in Bethlehem conurbation. Our main goal is to plan for a transport system that is: socially, environmentally and economically sustainable now and in the future, developed through co-creation and a participatory process. In analysing the current situation and deriving the indicators that characterise the transport system in the Bethlehem conurbation area, we have followed the same principles, identifying the problems, challenges and opportunities related to the social, environmental, economic and participative aspects of transport.

The main tasks undertaken during this phase have been:

- » Identifying, gathering, processing and analysing planning documents, policy documents, strategies relevant for the planning process, at national, regional, and local level.
- » Identifying, gathering, processing, and analysing of available data (qualitative and quantitative) related to land-use, mobility, demography, socio-economic development, environment, infrastructure, etc.
- » Collect additional data (mainly through desk research, maps analysis, local knowledge).
- » Select suitable topics and indicators for describing the status of mobility, transport and urban development in Bethlehem conurbation.
- » Prepare a baseline analysis, including a list of problems and challenges to be addressed by the plan (during scenarios development, measures, and implementation).

The following chapters present our main findings on the status quo of the transport system in Bethlehem conurbation.

### 3. DIAGNOSIS AND ANALYSIS

#### 3.1 Legislative, regulatory and institutional frameworks governing urban transport in Bethlehem conurbation

This chapter will focus on the institutional, legislative and regulatory frameworks governing the urban transport planning and operation sector. The focus is on understanding the relationships between stakeholders, the rules and regulations (at national, regional or local level) that might have an impact or hinder the decisions and proposals developed in the Mobility Study and the possible financial resources that can or could be used for ear-marked transport investments. Furthermore, it is important to understand all the projects that have been implemented between 2017 and now and the planned works and projects that might influence the future scenarios that are to be developed in the subsequent phases of the project.

##### 3.1.1 Analysis of institutional and financial arrangements for urban transport

###### *Stakeholders*

The following table shows the main stakeholders involved in transport planning and development.

*Table 1. Transport sector stakeholders and their role*

Institution	Main Role
Ministry of Transportation (MOT)	Planning of major transport development
Higher Transport Council (HTC)	Regulatory role of transport sector under the umbrella of MOT
Ministry of Public Works and Housing (MOPWH) – Roads Department	Implementation of infrastructure projects outside cities ( projects beyond municipality's authority)
Traffic Police	Monitoring and control of transportation, traffic, and road safety.
Municipalities (Bethlehem, Beit Jala, Beit Sahour, Doha, Al-Khader)	Planning, design, and implementation of transport development projects in line with the local urban planning
Bethlehem Governorate	Supervising and guidance the development in Bethlehem
Bethlehem Transportation Committee	Coordination between related stakeholders under the umbrella of Bethlehem Governorate
Ministry of Local Government (MoLG)	Supervising and guidance of municipalities in addition to organizing the development of local

Transportation sector in Bethlehem is being organised through cooperation between several parties, with each of them playing a different role according to their position and scope of work. Related legislations and regulations are supposed to help organising the relations between them and direct the development plans. The national level is supposed to set the general development plans in response to the needs of different areas and sectors.

Usually the relationship between the stakeholders is a formal relationship governed by protocols, while on the technical level there is a space for informal coordination. The relationship usually follows interactive communication based on the circumstances and the organisation of planning and follow up is below expectations. The urgency of the situation plays a role in the frequency of interaction and responsiveness of decision makers.

Each party is asking for more integration between stakeholders, however, at the same time, they tend to protect their zones of control. Basically, everyone appreciates if others commit to effective coordination as it

is so important, and even with the existence of a framework. the coordination on ground is not mature enough because many of the stakeholders are still not sharing their plans or trying to avoid the impact of the plans of others.

#### *Communication between the local and national level*

- A. Between government institutions and national level  
 Local government institutions in Bethlehem such as MoT, MoPWH, MoLG, and Police have to follow the government communication protocol when communicating to other ministries.
- B. Between municipalities and national level  
 Municipalities are independent entities that can communicate with other ministries directly. They can refer to MoLG in case they need support or when it is related to legal or public issues where MoLG has a direct role.
- C. Between Bethlehem Governorate and the national level  
 Bethlehem Governorate is the highest authority in Bethlehem and can communicate directly with other ministries. The transport Committee can communicate with other ministries via Bethlehem Governorate communication office.

#### *Bethlehem Transport Committee*

Bethlehem Transport Committee has been established according to the High Transportation Council bylaws and attached to Bethlehem Governorate. It involves representatives of the following stakeholders as members:

- » Bethlehem Governorate (organizer)
- » MoT office in Bethlehem
- » MoPWH office in Bethlehem
- » Traffic Police
- » Bethlehem Municipality
- » Beit Jala Municipality
- » Beit Sahur Municipality
- » Doha Municipality
- » Al-Khader Municipality.

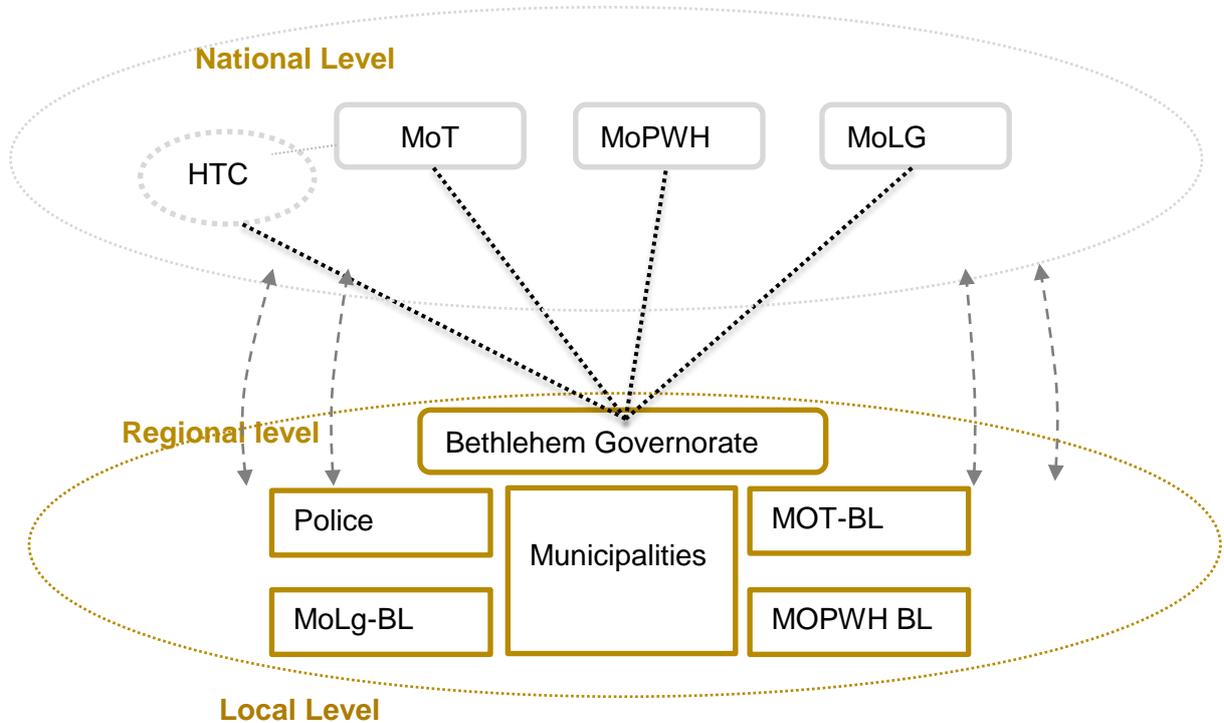
The main role of Bethlehem Transport Committee is to organize all efforts of all stakeholders towards the development of transport sector and to enhance the road safety conditions in Bethlehem. Unfortunately, development plans are fragmented among stakeholders and there are not commonly agreed plans available. This is an indicator of the weak organisation of the committee.

Bethlehem Transport Committee faces several challenges, mainly:

- » Poor enforcement of the committee decisions.
- » Coordination is still below expectations.
- » Municipalities are not sharing all their plans with the committee.
- » Developing the committee's and some of the its members' capacity is not a priority.

Follow up is one of the weak points in the relationship between all transportation development stakeholders in Bethlehem. Bethlehem Transport Committee depends on the assigned personnel by Bethlehem Governorate without the necessary bylaws and procedures that can ensure the commitment of members and follow up of activities and achievements. In collective issues related to the local transport development in Bethlehem, Bethlehem Transport Committee handles the communication with the national level. It is necessary to establish management manuals and M&E procedures for the committee to enhance the follow up function.

**Figure 3.** Institutional arrangements for the urban transport sector in Palestine



**Project implementation and financing**

Implementation of transport development projects is handled by related parties as shown below.

**Table 2.** Project implementation authorities in Palestine

Type	Management	Control
Area A (mainly urban areas)	Palestinian Authority	Palestinian Authority has full control
Area B (mainly urban or expansion areas)	Palestinian Authority + Israeli Authorities	Palestinian Authority has limited control
Area C (between cities)	Israeli Authorities	Projects should be approved by related Israeli authorities

The urban development/ transport related projects are financed through various sources.

**Table 3.** Project funding sources in Palestine

Donor/Supporter	Type of Projects
MoPWH	Linkages between cities
Municipalities	Internal roads
Donors (mainly international)	Anywhere
Private sector	Not available

**Table 3** shows what kind of projects are funded through what sources. It is important to mention that many implemented projects are funded through donor sources, while local and national financing sources are limited due to the political situation and other factors.

### **Tendering and Management**

Implementation of infrastructure projects follows the common tendering procedures, more likely FIDIC standards. The process is unified with differences in the technical requirements among tenders. The tendering process is usually transparent and managed according to the source of funding as follows:

- » Government funded projects are managed by the Central Supplies Department from the Ministry of Finance.
- » Municipality funded projects are managed by the municipalities.
- » International funded projects are co-managed by the donor and the municipality or the beneficiary institution.

### **Business Model**

The investment in transport development in Palestine is not a revenue generating investment. Transport systems do not focus on revenue generation, and hence private sector is not attracted to such investment. Furthermore, this model increases the load on the government and municipalities for ensuring transport development budgets.

In the absence of transport taxes, the government and municipalities are trying to ensure the necessary budgets by:

- » Reallocating the necessary budgets from other sources and
- » Looking for donations.

Recently, some of the municipalities started to find ways to attract private investments, which were included in their strategic plans. Such is the case of Doha Municipality's strategic plan (2018 - 2021) that suggested partnerships with private sector to establish revenue generating services with an investment of \$1 Million. In terms of budget, this is the second largest investment, with road rehabilitation being the first. Nevertheless, PPP is completely unregulated, at this moment, therefore partnership with private parties is still difficult to implement.

### 3.1.2 Analysis of the legal and regulatory framework for urban transport at local and national level

The following table summarises the main legislation related to the transport development projects, highlighting the main related clauses. The Road Safety Manual which is a main regulatory document for urban transport is briefly discussed in section 3.10.

**Table 4.** Main legislative acts governing the urban transport sector

Legislation	Activity	Details
<b>Transport Law (5) – 2000</b>	Deciding the locations of traffic signs (77)	Any party authorized by the Traffic Supervisor. Traffic Supervisor can decide, arrange, and change the traffic signs and their locations.
	Installing traffic signs (78)	Responsible authority with traffic supervisor and traffic police (exclusive responsibility)
<b>Acquisition Law (2) – 1953</b>	Public projects (2)	Any project for the benefit of the public that is approved by the Ministers Council
	Acquisition procedures (3-22)	Describing the procedures to be followed for the acquisition of the land
<b>Cities Planning Law (28) – 1936</b>	Responsibility of transport management	The law give the local city planning committee full control inside the city. In regional roads, other committees have the authority.
	Licensing (Briefly describe the procedure – flow chart)	Procedure of licensing buildings and changing on infrastructure
<b>Construction Permits (multiple legislations)</b>	Get a construction permit	Procedures to get the construction permit, requirements, and related authorities
<b>New Business Registration (multiple legislations)</b>	Register a new business	Procedures for registering a new business, requirements, and related authorities

### 3.1.3 Analysis of urban and transport planning documents at local and national level

#### **National Level Planning**

Several documents have been found describing national transportation development such as the following:

- **Challenges of Planning in Palestine – 2005**

This document summarises the planning system in Palestine in several areas including the development of transportation sector. Furthermore, it highlights the main constraints and challenges of planning in Palestine and focuses on the high level national goals to develop the different sectors.

Major constraints highlighted are as follows:

- » Unstable and uncertain political situation
- » Lack of sovereignty over resources
- » Impediments created by the spread of numerous Israeli colonies and related by-pass roads
- » Deteriorated physical environment purposely neglected by Israel through its years of occupation
- » The anticipated, but at the same time uncertain increase in population regarding returnees
- » The demographic structure of the Palestinian population where the young generation constitutes the majority of the population
- » Limited availability and accessibility to natural resources, e.g., water
- » High rates of unemployment coupled with limited job opportunities
- » Lack of unified planning laws and regulations
- » Israeli military actions and destruction of infrastructure in certain circumstances
- » The separation wall.

It should be noted that during the period between the inception of the Palestinian National Authority (PNA) and the winter of 2002, the PNA made considerable progress towards the planning construction of infrastructure compatible with a modern state with the assistance of overseas and local investment. However, Israeli incursions and aggression have since then been stepped-up in contravention of UN Security Resolutions 242 and 338 as well as the Oslo Accords and the Fourth Geneva Convention. Therefore, all the PNA institutions have been destroyed or seriously damaged, including furnishings and equipment and roads have been made unusable by bulldozers.

Major objectives for better planning:

- » Provide for the future needs of a growing population including repatriation of about 1/2 million returnees as well as the improvement of the living conditions of the camp populations.
- » Provide a long-term plan that will be economic in its use of land resources, providing development opportunities after planning period.
- » Stop random and environmentally harmful development and provide an efficient urban structure at the regional level.
- » Provide areas for development without endangering important natural resources.
- » Protect agricultural land as a part of natural resources which will be an asset for economic production, business activities, and job opportunities.

The regional and urban objectives of the plan are:

- » Provide sufficient housing and public services with appropriate standards throughout the region.
- » Provide the required land needed for residential, commercial, recreational, green areas, public services and private services development.
- » Provide regional grading of settlements according to economic and functional roles.
- » Location of future urban development should take place on land of marginal values in terms of natural resources and environmental protection.
- » Ensure the opportunities for development of tourism and recreational utilities.
- » Establish land requirements for development and protection.

For the inter and intraregional level, the transportation plan aims to solve the existing problems and satisfy the future demands in the transportation sector by the following main objectives:

- » Provide a transportation system that is integrated with the needs of the future urban development patterns in the region.
- » Minimize the negative impacts of transport development of the environment and the built-up areas.
- » Provide a system that serves both the economic development and personal transportation needs.
- » Encourage the use of public transportation and reduce the use of private cars.

In terms of network and facilities, the main strategy of the regional plan as shown in the plan map depends upon the following:

- » Optimize the use of the existing network.
- » Propose new hierarchy and standards for the regional network, which helps to increase the capacity of the existing network without or with the minimum possible investment.
- » Upgrade the structure and geometrical condition of the existing network. This will help to improve traffic flows (capacity) and safety in the road network.
- » Upgrading - expansion of the roads from 2 to 4 lanes or to 6 lanes. The land is already reserved for this purpose and the investment will be minimum.

- **Urgent Needs for Developing the Palestinian Transportation Sector – 2008**

This document describes the current situation of the Palestinian roads network focusing on the following:

- » Roads Rehabilitation including: roads between cities, coast road in Gaza, the planned road between West Bank and Gaza.
- » Organizing transportation and related legislations and systems.
- » Other airports, sea ports, railways, and regional linkages and borders.

The main challenges highlighted by the document are:

- » No direct connection between West Bank and Gaza.
- » Isolation of Palestinian areas by Israel.
- » Impact of Israeli occupation on planning and economic development.
- » High shipping costs.
- » Unavailability of resources for developing transportation sector.

The document estimated the requested budgets for developing the transportation sector as follows:

**Table 5.** Budget necessary for the transport sector development, as presented in *Urgent Needs for Developing the Palestinian Transportation Sector – 2008*

Sector	Budget (\$)	Percentage
Internal Shipping	4,773,000	2.78%
Roads Rehabilitation	109,570,000	63.84%
Airports	12,333,706	7.19%
Sea ports	7,207,760	4.20%
Borders	27,700,000	16.14%
Weather forecast	2,006,000	1.17%
MoT capacity	8,054,000	4.69%
<b>Total</b>	<b>\$171,643,706</b>	<b>100%</b>

As shown in the above table, the focus is mainly on the rehabilitating the current infrastructure, without paying attention to other ways of developing the transportation such as developing transportation systems, policies and regulations, and enforcing related laws.

- **Transportation Sector Strategic Plan (2011 - 2013)**

This plan focuses on the following main targets:

- » Developing a safe and environment friendly transportation system.
- » Enhancing the public transportation quality and safety.
- » Minimizing the transportation accidents and pollution.

The strategy identified a wish list that cannot be measured since the stated objectives are not measurable or timetabled, especially those objective related to the transportation system and safety. It is not easy to guess what the suggested transportation system is or to what extent the transportation safety will be improved. Furthermore, the strategy didn't pay attention to the specific needs or the difficulties and limitations of different areas. Also, the strategy didn't address the potential integration with other stakeholders such as municipalities, MoPWH, or Police and so on.

### *National Level Reports and Documents*

Several national reports have been found describing the situation of the transportation sector and achievements of related parties. The following are the main found reports with summarized information related to the transportation development.

- **MoT Second Annual report - 2011**

This report summarises the Ministry of Transportation (MoT) goals, including the following:

- » Enabling a suitable legal environment for the transportation sector.
- » Enhancing transparent and sustainable institutional system that supports economic development.
- » Enhancing the efficiency of the transportation sector.
- » Integration of Palestine with the regional transportation networks.
- » Enhancing the transportation safety.
- » Developing partnership with the private sector.
- » Enhancing the human resources in the transportation sector.

The report also highlighted the main achievements as follows:

- » Approval of the national traffic signs manual.
- » Taxi service traffic routes database.
- » Transportation technical safety standard.
- » Database of traffic signs inside urban areas including some information about schools and other safety measures.
- » Ensuring scales to weigh trucks on the road.
- » Establishing the road safety patrol.

- **HTC – First Annual Report – 2012**

The report describes the role of High Transportation Council (HTC), challenges, and some achievements as follows:

The main goal of the High Transportation Council is to improve the transportations systems and safety. Its role is to:

- » Develop transportation policies and plans.
- » Ensure integration and coordination between related parties.
- » Establish local transportation committees.

The report highlights the following main weaknesses:

- » Integration and coordination between related parties is below expectation.
- » There is a lack of information about transportation that can help in better planning.
- » There are poor capacity and limited resources of related parties.
- » There is a very low level of private sector and NGO sector investment.

The main activity performed by the HTC is the transportation safety audit performed in certain places and the necessary improvements identified. Results are being communicated with MoLG, municipalities, MoPWH, and traffic police.

- **HTC – Second Annual Report – 2013**

The report mentions the same weaknesses presented in the previous report.

The main projects implemented:

- » Local School Road Safety Committees: The project involved awareness and training in addition to supplying safety tools for students. Another main component was coordination with municipalities and other stakeholders to remove any obstacles on the roads and enhance road's conditions. The report mentioned that these stakeholders have been informed, but it is not clear what happened later.
  - » HCT participated in developing the technical specifications of road safety that were developed by GIZ.
- **MoT Annual Statistical Report - 2016**

This report summarizes many statistics related to the transportation sector, where the main related indicators are the following:

- » Number of vehicles in Palestine: Around 300,000, other uncounted Israeli licensed or unlicensed vehicles are used.
- » Car usage: 9 vehicles/1000 citizens.
- » Vehicles: 78% private vehicles, 8% trucks, 7% trade/shipping vehicles, 5% taxis, 2% governmental vehicles.
- » New cars in 2016: 26,371 (Ramallah 39%, Nablus: 13%, Hebron: 12%, Jenin: 12%, Bethlehem and Tulkarm: less than Jenin but not listed).
- » New cars in 2016: 82% private, 6% trucks and taxi.
- » Taxi: 74% between cities, 26% city taxi.
- » Busses: 969 busses - 20% in Hebron, 15% in Nablus & Ramallah, 13% in Jenin.
- » Rent cars: 251 car rental companies - 32% in Ramallah, 16% in Hebron, 11% in Bethlehem, 11% in Nablus, 11% in Jenin, 6% in Qalqelia, 4% in Tulkarm, 4% in Jericho;
- » Tourist Transportation Vehicles: 5 companies - 4 in Bethlehem and 1 in Jericho;
- » Registered Accidents: 10,630, 18% increase from 2015;
- » Injuries: 9,447 (89% minor, 8% moderate, 2% dangerous and fatal).

### **Local Level Planning**

Unfortunately, there are no specific or integrated plans for developing the transportation sector in Bethlehem. Each of the stakeholders has some fragmented analysis of the problem from their point of view and some partial solutions for their side of the problem. In general, this situation leads to dealing with problems in an interactive or fire-fighting strategy where the solutions come as a response to the current situation without a collective understanding of the problem and its root causes. Therefore, all development initiatives usually deal with partial problems and it was difficult to design proper and comprehensive solutions.

The Transport Committee led by Bethlehem Governorate is trying to bring all stakeholders together to overcome this problem. In general, everyone is convinced that this committee still doesn't have the expected level of authority to enforce a proper level of coordination and planning to serve the whole area of Bethlehem.

Prioritizing of transport development projects usually follow the evolving needs of the different areas. In general, municipalities try to find solutions for the most urgent problems. Transport development projects don't follow a strategic plan due to many challenges such as limited capacity of municipalities, weak legal environment, crowded areas, and limited land area.

### Sustainability

Sustainability in transport projects is not guaranteed, and hence all stakeholders are seeking for donations all the time to fulfil the continuous and developing needs of the community. This is due to the absence of revenue generating services and almost full dependency on other ways to finance development projects. Related institutions can hardly afford their operating budgets. Therefore, all transport development projects, as any other projects, are subjected to the probability of finding a donor. We have witnessed deterioration of infrastructure in many areas due to no donors found at the right time.

Planning under these circumstances is more likely dreaming, and plans become like a wish lists due to the absence of budgets. This is not a problem of one institution, it is a common symptom of almost all Palestinian institutions that have been founded on the basis of “getting support” not on the basis of “sustainable economy”.

Designing a new business model for the transport system has not been widely used in the past. The main initiative in this scope is managing the street parking inside the cities implemented by private sector. However, expansion of the revenue generation concept in transport needs to be assessed in terms of economic feasibility, sustainability, and sociocultural dimensions.

### Current Projects in Bethlehem area

Understanding the current on-going (or tentative) projects in Bethlehem is a key activity for building the future scenarios in the next stage of the project. For this purpose, the municipalities involved in the project have been asked to provide a list of projects that would have an impact on traffic in the next 20 years\*. This list includes approved and tentative projects. Together with socio-economic data (population, employment, and car ownership growth) they will constitute the Business-As-Usual scenario or the base scenario for 2030.

**Table 6.** On-going and future projects in the Bethlehem area

Item	Project	Location	Status
1	Al-Attan Road	Bethlehem	Design completed by the Municipality
2	Al-Bandak Road	Bethlehem	Design completed by the Municipality
3	Aljabal Road	Bethlehem	Design completed by the Municipality
4	Manger Street	Bethlehem	Design completed by the Municipality
5	Beit Sahour Main Road	Beit Sahour	Design completed by the Municipality
6	Beit Jala Main Road	Beit Jala	Design stage
7	Sustainable Urban Planning and Growth Project	Bethlehem Conurbation	On-going project (Duration for 2 years)
8	Rehabilitation of the Al Meyah Street from Wad Shaheen roundabout to Al Madras Street junction in Al Saff area	Bethlehem	Under preparation
9	Rehabilitation of Morcos Stairs	Bethlehem	In the design stage / Tender documents are being prepared

10	Rehabilitation of Star Street	Bethlehem	Design stage
11	Rehabilitation of Al Wardia Street, Handal stairs and Jaljal stairs	Bethlehem	Tendering Stage
12	Rehabilitation of the Orient Star Street, the Catholic Action Roundabout and part of Star Street	Bethlehem	Tendering Stage
13	Rehabilitation of internal roads in Bethlehem (Al-Qanater Street \ Al-Jarashi Street \ Tkiyya Stna Mariam Street\ From Al-Saff roundabout to Al Madares Street \ Mar Youssef Al-Atan Street \ Buqaih Al Thoghrah Street)	Bethlehem	
14	Construction of Hindaza-Wad Shaheen Roundabout Road	Bethlehem	Under preparation
15	Construction of Artas- Hindaza Road	Bethlehem	Under preparation
16	Karkafeh - Beit Sahour (Greek Orthodox Housing) Roads	Bethlehem	Under preparation

*\*Note: Not all municipalities have provided this information.*

### **Main dysfunctionalities**

The main dysfunctionalities that have been identified, regarding the legislative and institutional framework are:

- » Legislation is fragmented and not integrated because legislation has been developed along different political authorities including British, Israeli, Jordanian, and Palestinian authorities.
- » Legislation has not been updated in a while as the Legislative Council is idle since more than 10 years. In addition, the Palestinian Authority didn't conduct a comprehensive legal reform to update legislation and ensure better integration.
- » Enforcement actions are out-dated and not appropriate for today's circumstances. For example, the penalty for constructing without a permit, discovering that the construction permit has been given upon misleading information, not fulfilling the construction permit conditions and related technical requirements or not fulfilling the technical construction or design requirements is, according to the Palestinian City Planning Law (1936) limited to 50 Palestinian Pounds and limited to 200 Jordanian Dinars (less than \$200) according to the Jordanian law (1966).
- » Enforcement is poor due to the limited control and limited capacity of the Palestinian Authority.

Enforcing the law is a challenge in Palestine in general due to the limited control of the Palestinian Authority on land and borders, interruptions of Israeli army, limited access to many areas, limited capacity of related institutions, and sociocultural factors. Palestinian legal environment requires serious reforms that ensure the update, integration, and enforcement of legislations. In some cases that require a legal solution, justice institutions may not be able to execute court decisions.

In terms of planning, the focus of all transport strategies and development plans is mainly on roads safety in addition to rehabilitation of existing roads. They suffer from several weaknesses such as:

- » Transport development planning is fragmented among related stakeholders and many topics are missing.
- » Plans didn't pay enough attention to investments in other transportation systems such as trains, buses, alternative transportation modes.
- » Attracting private sector investment is below expectation.
- » Plans didn't include clear measures of transport development.
- » There are no or incomplete transposition of general goals into action plans.
- » Plans didn't tackle important issues related to transport development such as poor urban planning and weak legal environment.

Stakeholders in Bethlehem usually face many challenges, mainly the following:

- » Ensuring the necessary budgets is not guaranteed.
- » The legal environment is not reliable enough to plan sustainable development where justice institutions might not be able to completely enforce the law.
- » Cooperation of related stakeholders might not be guaranteed.
- » Accountability is poor, which opens the door for not fulfilling to obligations by either individuals or institutions.
- » The capacity of municipality and other stakeholders is below expectations.

Due to these reasons, the strategic and operational plans of municipalities and other stakeholders usually fail to achieve the stated goals and only partial implementation can be achieved. During the review of some strategic plans, it was obvious that some of the municipalities were shy to clearly state their targets as they are convinced that they will face many challenges.

### Conclusions

To solve the transport problems and ensure sustainable development in Bethlehem, it is important to undertake the following:

- » Identify the current and future needs of Bethlehem area

Needs assessment might be considered as the responsibility of the Bethlehem Transport Committee, but it is important to offer the necessary support to bring all stakeholders together, to develop a collective and agreed transport development plan. Such an agreed plan will minimize fragmentation and encourage integration.

- » Promote proper sustainable transportation models among related stakeholders

Municipalities and other stakeholders didn't adapt any sustainable transportation models, and all development projects are on the waiting list for finding a donor or some budget allocation. It is time to start thinking of sustainability in transportation sector. Furthermore, it is time for innovative solutions, not only roads rehabilitation.

- » Promote the attraction of private sector investments in transport development

Private sector is not a partner in transport development and the total private sector investments in transport development approaches zero. Such projects are not attractive to the private sector as they are not following any economic models. This option should be taken in consideration in planning for transport development.

- » Activate the Transport Committee and build their capacity

Activating the Bethlehem Transport Committee is a key solution towards collective transport development planning and monitoring. It is the best and fastest way to bring all stakeholders and organize the

development of an overall transport plan. Developing the capacity of the committee should be considered as a priority.

- » Enforce the related legislations or bylaws

Besides the relationships between stakeholders, it is important to integrate the transport development planning with justice sector and related governmental institutions to help enforcing the related bylaws and regulations. The major objective in this regard is to authorize Bethlehem Transport Committee.

- » Establishing a M&E mechanism for the transport system efficiency

Decisions and plans implementation should be monitored systematically in order to evaluate the progress and commitment of stakeholders towards the agreed development. M&E should follow clear procedures rather than occasional orders. M&E helps in keeping the development process on the right track and helps in finding solutions for problems very quickly.

- » Ensuring coordination with related partners for providing the necessary budgets for transport development projects

As long as municipalities and other stakeholders lack the necessary budgets to develop the transport sector, it is important to agree on the financing or fundraising scheme to ensure the necessary budgets. For all suggested projects, there should be allocation of the necessary budgets.

### 3.2 Socio-economic data and trends

In the last decades, various studies and analyses have been focusing on identifying the exogenous socio-economic variables and trends that influence the current condition, the performance and the development of land use and the transport system within a city. The EU research project PROSPECTS<sup>2</sup> has identified main variables, based on the survey of multiple European cities and they are as follows: population growth, economic growth, changes in car ownership, changes in job/employment structure, changes in employment location, age structure of population, changes in total employment, changes in relative prices, changes in tourism and leisure activities. In this chapter, we will present some of these socio-economic data and trends related to Bethlehem (and/ or Palestine). It is important to mention that these variables will play an important role in developing the future scenarios in the subsequent phases of the project.

#### Demography

In general, population has seen a tremendous growth in the Palestinian Territories, having almost doubled in the last 20 years, from approximately 2.8 million in 1997 to 4.8 million in 2017.<sup>3</sup> The same trend can be observed also at Governorate and city level, for Bethlehem. Thus, the population of Bethlehem Governorate has increased from approximately 130,000 in 1997<sup>4</sup> to 217,400 in 2017, according to the 2017 Census. The following graphs and maps provide an overview of the most important demographic statistics at various levels\*\*.

By analysing the demographic trends in the last 10 years, it can be concluded that the population has grown with an average of 2.6% per year across all localities that are part of the study area. Considering that no extraordinary (disruptive) events will take place and by applying this growth percentage, it can be deduced that the population of Bethlehem conurbation will be approximately 152,000 in 2030 and 198,000 in 2040. In the subsequent phases of the project, in order to develop various scenarios, multiple options will be considered (pessimistic, moderate, optimistic growth, for example), since demographic trends have a high impact on mobility and the performances of the transport system. In general, population growth has a linear direct relationship with transport and mobility demand, although it depends also on the age structure, population density, land use and other external factors. As a general remark, future scenarios need to accommodate for a much higher population, with different needs and expectations.

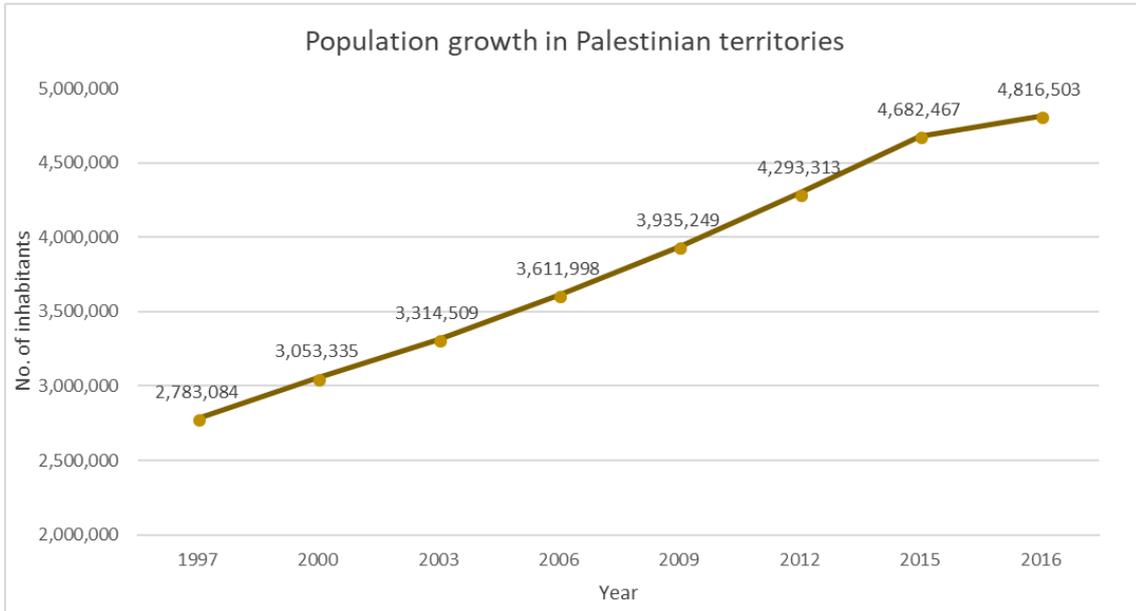
\*\* The differences in numbers between some tables are due to the fact that some data reflect estimates and forecasts, while others are based on Census population data. Moreover, due to "informal" moving of population in search for work, demographic data might vary, based on the counting method.

<sup>2</sup> PROSPECTS (Procedures for Recommending Sustainable Planning of European City Transport Systems), *Task 12 Reports: Trends and Scenarios* (Stockholm: Sweden, 2001).

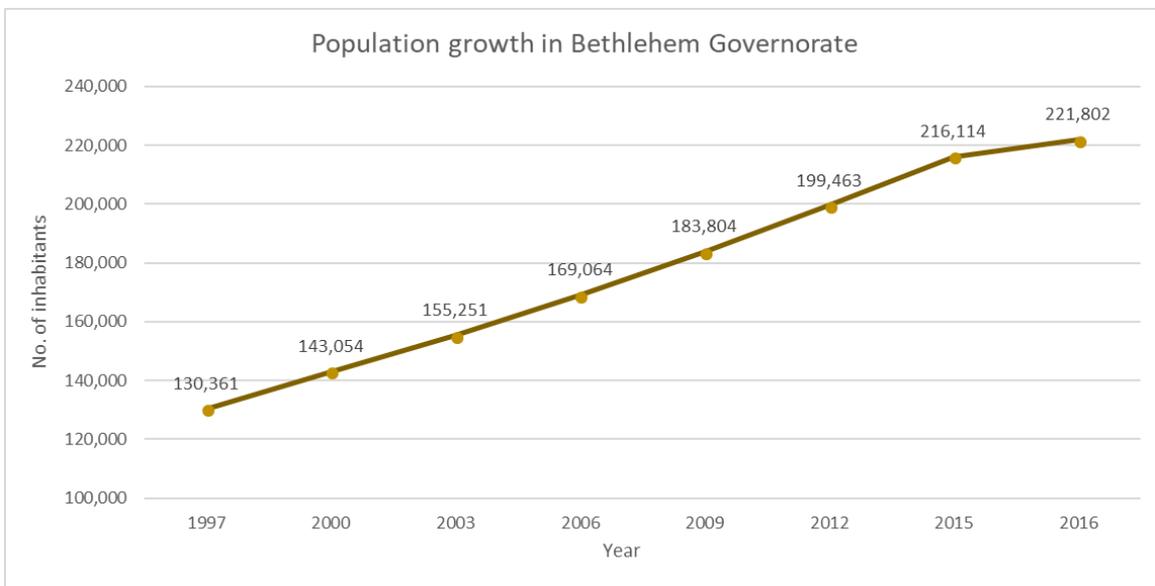
<sup>3</sup> PCBS Palestinian Central Bureau of Statistics, *Preliminary Results of the Population, Housing and Establishments. Census, 2017* (Ramallah: Palestine: 2018)

<sup>4</sup> PCBS, *Localities in Bethlehem Governorate by Type of Locality and Population Estimates, 2007-2016*, (2018) Available at: [http://www.pcbs.gov.ps/Portals/\\_Rainbow/Documents/betlhm.htm](http://www.pcbs.gov.ps/Portals/_Rainbow/Documents/betlhm.htm)

**Figure 4.** Population growth in the Palestinian Territories, based on mid-year population estimates 1997-2016<sup>5</sup>



**Figure 5.** Population growth in the Bethlehem Governorate, based on mid-year population estimates 1997-2016<sup>5</sup>

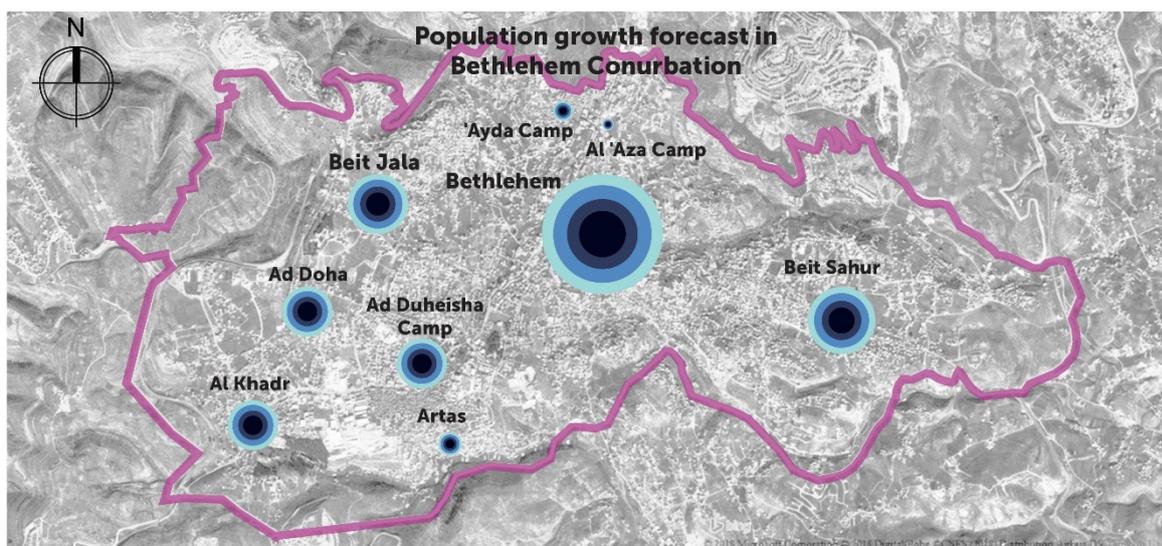


<sup>5</sup> PCBS, *Estimated Population in the Palestinian Territory Mid-Year by Governorate, 1997-2016*, (2018), Available at: [http://www.pCBS.gov.ps/Portals/\\_Rainbow/Documents/gover\\_e.htm](http://www.pCBS.gov.ps/Portals/_Rainbow/Documents/gover_e.htm)

**Table 7.** Population growth and distribution by locality in the study area of the Mobility Study, based on mid-year population estimates 1997- 2016<sup>5</sup>

Locality Name	Type*	Year									
		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
'Ayda Camp	3	2,598	2,670	2,744	2,820	2,898	2,978	3,059	3,142	3,226	3,311
Al 'Aza Camp	3	1,510	1,552	1,595	1,639	1,684	1,731	1,778	1,826	1,875	1,924
Beit Jala	1	11,610	11,933	12,263	12,602	12,950	13,308	13,672	14,043	14,419	14,798
Bethlehem (Beit Lahm)	1	24,949	25,641	26,351	27,079	27,827	28,596	29,380	30,176	30,983	31,799
Beit Sahur	1	12,212	12,551	12,898	13,254	13,620	13,997	14,381	14,770	15,165	15,565
Ad Doha	1	9,631	9,898	10,172	10,453	10,741	11,038	11,341	11,648	11,960	12,275
Al Khadr	2	9,651	9,919	10,194	10,475	10,765	11,062	11,365	11,673	11,986	12,301
Ad Duheisha Camp	3	8,626	8,866	9,111	9,363	9,621	9,887	10,158	10,434	10,713	10,995
Artas	2	3,617	3,717	3,820	3,926	4,034	4,146	4,259	4,375	4,492	4,610
<b>Urban Total</b>		<b>58,402</b>	<b>60,023</b>	<b>61,684</b>	<b>63,388</b>	<b>65,138</b>	<b>66,939</b>	<b>68,774</b>	<b>70,637</b>	<b>72,527</b>	<b>74,437</b>
<b>Rural Total</b>		<b>13,268</b>	<b>13,636</b>	<b>14,014</b>	<b>14,401</b>	<b>14,799</b>	<b>15,208</b>	<b>15,624</b>	<b>16,048</b>	<b>16,478</b>	<b>16,911</b>
<b>Camps Total</b>		<b>12,734</b>	<b>13,088</b>	<b>13,450</b>	<b>13,822</b>	<b>14,203</b>	<b>14,596</b>	<b>14,995</b>	<b>15,402</b>	<b>15,814</b>	<b>16,230</b>
<b>Total Bethlehem Con.</b>		<b>84,404</b>	<b>86,747</b>	<b>89,148</b>	<b>91,611</b>	<b>94,140</b>	<b>96,743</b>	<b>99,393</b>	<b>102,087</b>	<b>104,819</b>	<b>107,578</b>

\* Locality Type: 1- Urban 2- Rural 3- Camps



Locality	2007	2017	2030	2040
Bethlehem	25,000	32,000	45,000	59,000
Beit Sahur	12,000	16,000	22,000	29,000
Beit Jala	11,000	15,000	21,000	27,000
Al Khadr	9,500	12,500	17,500	22,500
Ad Doha	9,500	12,500	17,500	22,500
Artas	3,500	4,500	6,500	8,500
Ad Duheisha Camp	8,500	11,000	15,500	20,500
Ayda Camp	2,500	3,500	4,500	6,000
Al 'Aza Camp	1,500	2,000	2,500	3,500

**Map 1.** Population growth forecast in Bethlehem conurbation, based on a 2.6% uniform annual growth (numbers have been approximated to 500)

Population age structure is also an important variable when planning for urban transport and mobility. Age structure matters because: (a) people at various ages have different levels of activities; (b) people in various age groups have different transport needs, for different reasons – to schools accompanied, to school on their

own, to work, for shopping, leisure, tourism, etc.; (c) people of various age need different/ adapted means of travel: e.g. older people are more likely to use public transport, while younger people (teens, adolescents) are more likely to use walking and cycling.

Detailed data on age structure at city level has not been found, but the Census of 2017 in Palestine provides extensive data at regional (governorate) and country level. We expect that the age structure at municipality level will present no significant deviations or variations compared to the aggregated regional/ national ones. The table below shows data for selected age groups, per sex, in Bethlehem Governorate, in Palestine and in comparison, in the Netherlands (as a representative country for Europe). The data shows striking differences between age structure, with Palestine (and Bethlehem Governorate as well) presenting high percentages of young people, with almost 70% of the population being younger than 30 years of age (45% younger than 18), and only 6% older than 60.

**Table 8.** Population by selected age groups and sex in Bethlehem Governorate, Palestine and The Netherlands

	Persons 60 years and older			Persons between 18 and 29 years old			Persons between 0 and 17 years old			Total population		
	F	M	Both	F	M	Both	F	M	B	F	M	B
<b>Bethlehem Gov.</b>	6,702	6,093	12,795	23,751	24,755	48,506	43,541	45,810	89,351	105,475	109,572	215,047
Percentage	3%	3%	6%	11%	12%	23%	20%	21%	42%	49%	51%	100%
<b>Palestine</b>	123,288	108,149	231,437	521,584	544,736	1,066,320	1,022,724	1,074,751	2,097,475	2,311,374	2,394,227	4,705,601
Percentage	3%	2%	5%	11%	12%	23%	22%	23%	45%	49%	51%	100%
<b>Netherlands</b>	2,249,161	1,978,841	4,228,002	1,263,675	1,305,730	2,569,405	1,660,523	1,743,575	3,404,098	8,606,405	8,475,102	17,081,507
Percentage	13%	12%	25%	7%	8%	15%	10%	10%	20%	50%	50%	100%

F - Females, M - Males, B - Both sexes

Source: PCBS, 2018<sup>6</sup> and CBS, 2018<sup>7</sup>

### Economic development and employment

Conflicts and political instability have caused a slowdown of the economic growth in the Palestinian Territories. This is reflected in all economic indicators at various scales, placing the country as one of the poorest in the region. Thus, in 2015, Gross Domestic Product (GDP) per capita was 1,744.5 \$ (2,267.2 \$ in West Bank and 996.3 \$ in Gaza)<sup>8</sup>, less than half of that in Jordan (4,096.0 \$) and about 20 times lower than the one in Israel (35,691.0 \$)<sup>9</sup>. GDP has also seen an unpredictable fluctuation, with a drop in 2014, after which it has followed a steady increasing trend (see [Figure 6](#)). Data regarding GDP levels and trends at Governorate and city level could not be found, but we expect that Bethlehem would not present significant variations compared to the West Bank data.

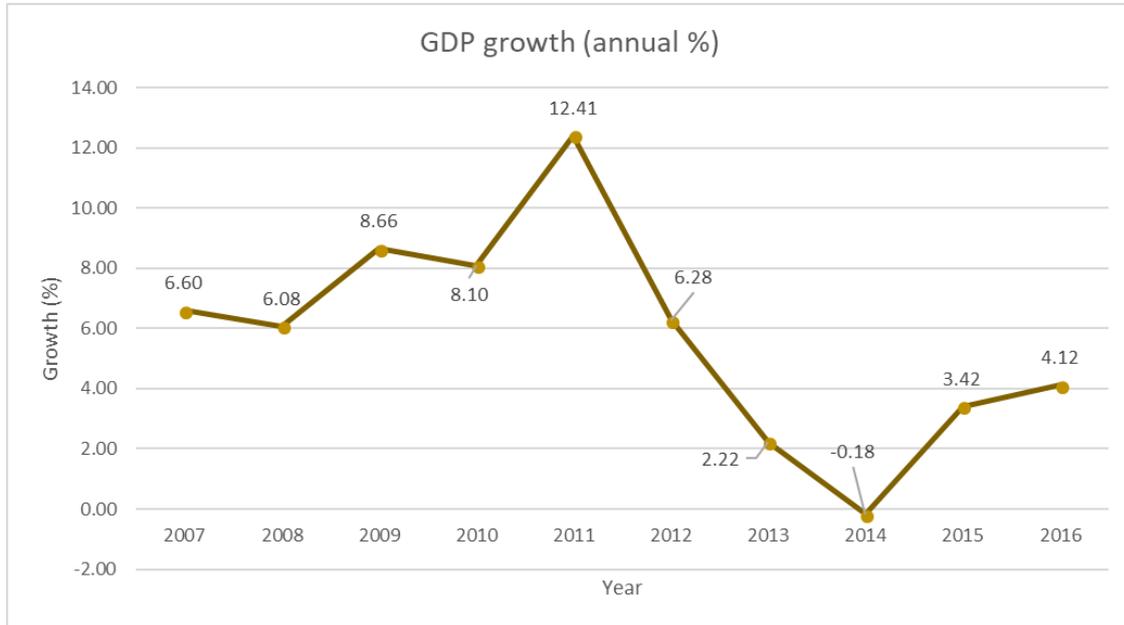
<sup>6</sup> PCBS, *Preliminary Results Census, 2017* (Ramallah: Palestine, 2018), p. 36

<sup>7</sup> CBS Centraal Bureau voor Statistiek, *Population, sex, age and marital status*, (2018), Available at: <https://opendata.cbs.nl/statline/#/CBS/nl/dataset/7461bev/table?dl=5052>

<sup>8</sup> PCBS, *Palestine in Figures 2016* (Ramallah: Palestine, 2017), p.7

<sup>9</sup> The World Bank, *World Bank Open Data*, (2018) available at: <https://data.worldbank.org/>

**Figure 6.** GDP growth in the Palestinian Territories 2007 – 2016



Source: The World Bank, 2018<sup>9</sup>

Unemployment levels are also relatively high in Palestine. According to the Census of 2017, the unemployment rate in Palestine was 27.2%, with a much higher rate for females – 40.1% and a high disparity between Gaza (48.2%) and the West Bank (13.2%)<sup>8</sup>. Despite its touristic and economic potential, Bethlehem Governorate is experiencing one of the highest unemployment rates in the West Bank area, reaching 21.3% in 2016, due to the occupation which has a direct negative effect on the economy, contributing to high unemployment and poverty rates. Israeli restrictions have affected people employed in various sectors: tourism, trade, industry and agriculture. Unemployment is a major challenge in Bethlehem, in all its localities, affecting both urban and rural areas, but also the refugees' camps, which are facing severe employment problems, even though many of their residents have completed a higher education degree<sup>10</sup>. The city/village profiles compiled by ARIJ in 2010 offer a picture of this data for the various localities in Bethlehem conurbation. Thus, according to these studies, unemployment rates were as follows: Bethlehem – 27.0%, Beit Sahur – 17.0%, Beit Jala – 17.0%, Artas – 22.0%, Al Khader – 20%, Ad Doha – 17.0%, Ad Duheisha Camp – 40.0 %, 'Ayda Camp – 64.0%, Al 'Aza Camp – 52%<sup>11</sup>. Recent collected data show the following number of unemployed people per locality in our study area (**Table 9**).

<sup>10</sup> United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA), *Refugees Camps in the West Bank*, (2018), Available at: <https://www.unrwa.org/where-we-work/west-bank/>.

<sup>11</sup> ARIJ Applied Research Institute Jerusalem, *Various City/Village Profiles*, (Bethlehem: Palestine, 2010).

**Table 9.** Number of unemployed people per municipality in the study area

Locality	Number
Bethlehem	1,013
Beit Jala	397
Beit Sahour	411
Al Khader	453
Ad Doha	132
Artas	365
<b>Total</b>	<b>2,771</b>

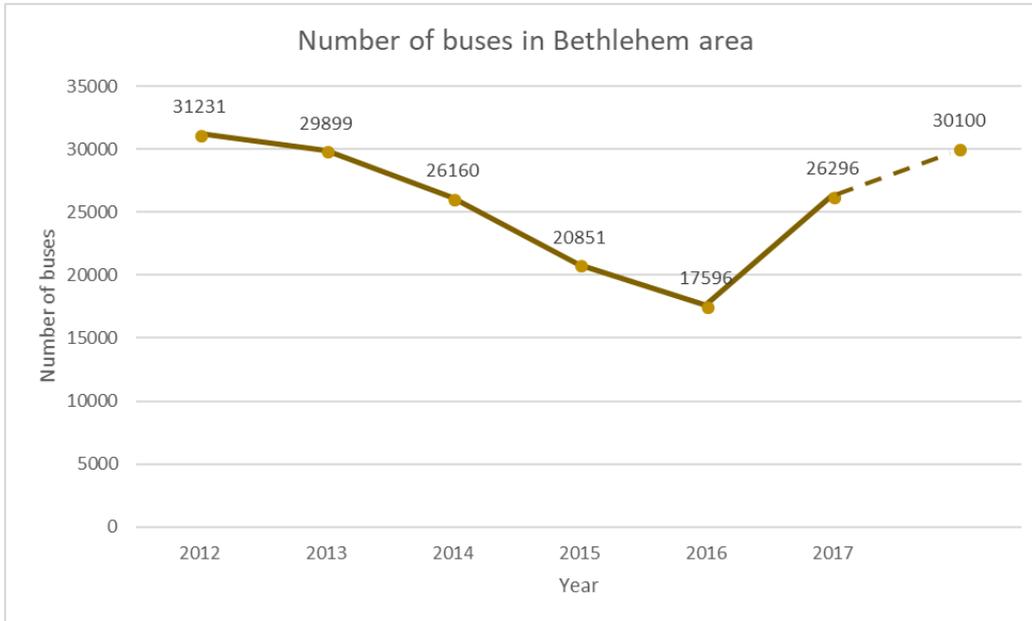
Source: PCBS, 2018, database 2017

The distribution of labour by economic activity was as follows:

- » Bethlehem: Government or Other Employees Sector (30%), Service Sector (25%), Trade Sector (23%), Industry (18%), Israeli Labour Market (3%), Agriculture sector (1%).
- » Beit Sahur: Industry (34%), Trade Sector (27%), Government or Private Employees Sector (17%), Services Sector (11%), Agriculture sector (6%), Israeli Labour Market (5%).
- » Beit Jala: Service Sector (30%), Trade Sector (25%), Industry (20%), Government or Private Employees Sector (20%), Agriculture sector (5%).
- » Artas: Agriculture Sector (51%), Israeli Labour Market (19%), Government or Other Employees Sector (13%), Trade Sector (13%), Industry (3%), Service Sector (1%).
- » Al Khader: Agriculture Sector (35%), Israeli Labour Market (30%), Government or Private Employees Sector (10%), Trade Sector (10%), Industry (10%), Service Sector (5%).
- » Ad Doha: Government or Private Employees Sector (40%), Trade Sector (20%), Israeli Labour Market (15%), Service Sector (15%), Industry (10%).
- » Ad Duheisha Camp: Services Sector (40%), Israeli Labour Market (35%), Government or Other Employees Sector (10%), Trade Sector (10%), Industry (3%), Agriculture Sector (2%).
- » 'Ayda Camp: Israeli Labour Market (78%), Government or Other Employees Sector (18%), Trade Sector (3%), Service sector (1%).
- » Al 'Aza Camp: Government or Other Employees Sector (35%), Service sector (25%), Trade Sector (23%), Israeli Labour Market (17%).

Tourism is one of the main economic activities in Bethlehem conurbation and it has a high impact on local mobility. Therefore, it is important to understand tourism related statistics and trends. Tourism is mainly represented by organised/ guided tours that use large dimensions buses for transporting the tourists around the city (to/ from hotel, main touristic attractions). In general, touristic buses pose a big challenge to mobility in the Bethlehem conurbation. In the last years, between 17,500 (in 2016) and 31,000 buses (in 2012) have been using the network, without restrictions (**Figure 7**).

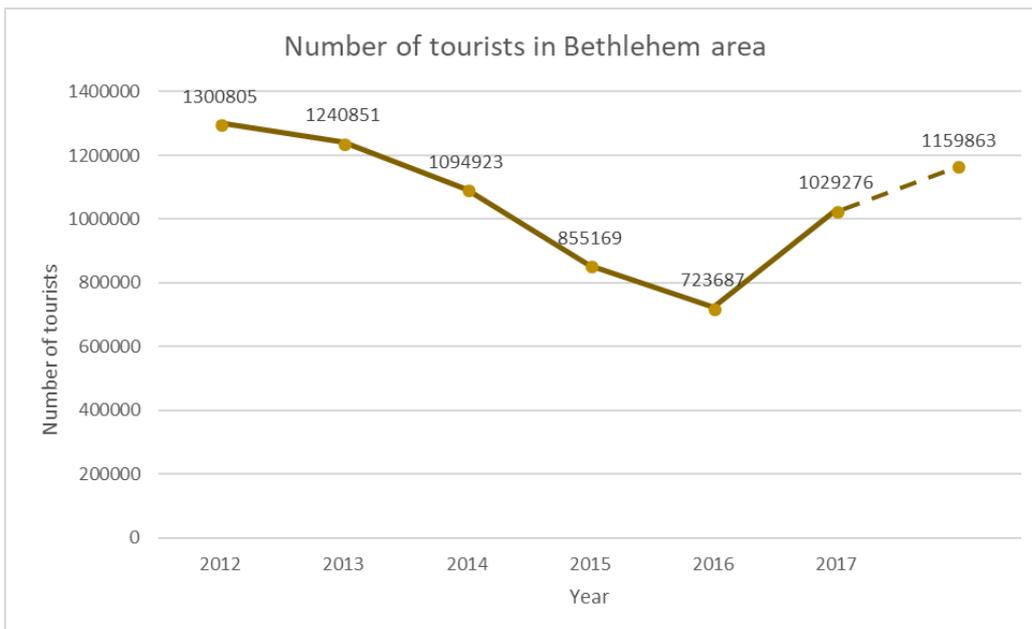
**Figure 7.** Number of tourist buses in Bethlehem area



Source: Bethlehem Municipality, 2018

In the last years, a decline in the number of tourists has been registered, mainly due to unrest and political instability in the Middle East. Nevertheless, in 2017 and beginning of 2018, numbers have begun to rise again, with 37% more tourists in the first four months of 2018 as compared with the same period in 2016 (**Figure 8**).

**Figure 8.** Number of tourists in Bethlehem area



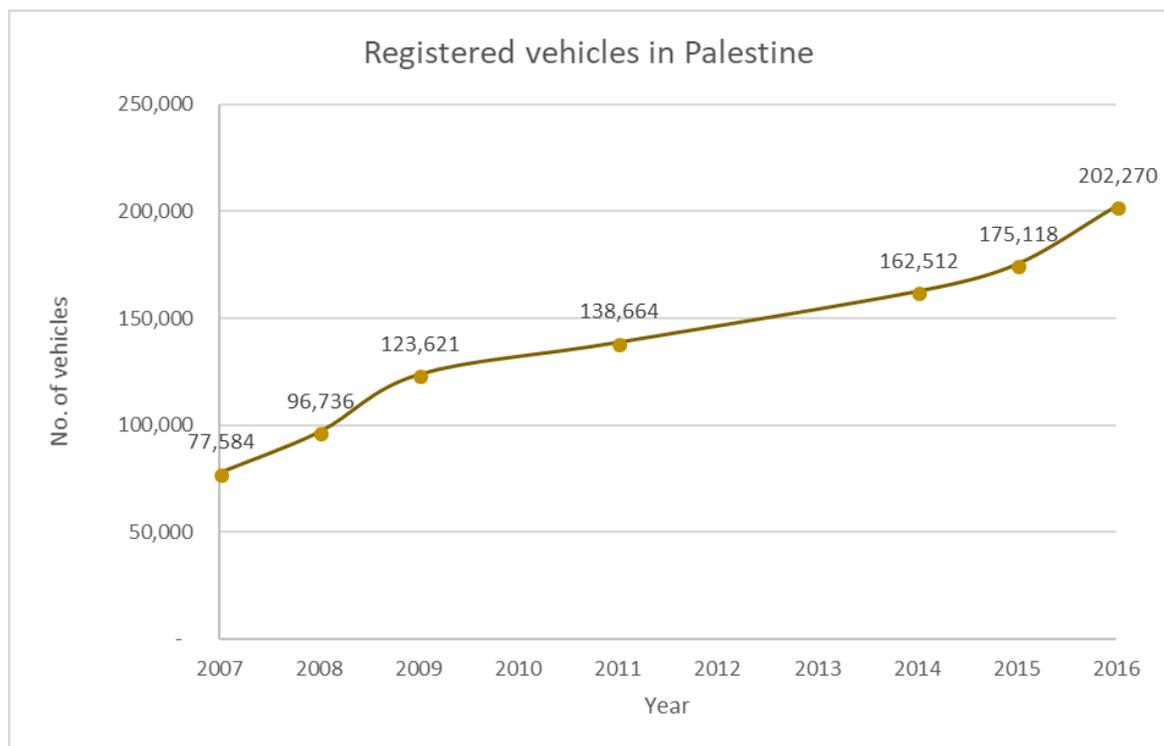
Source: Bethlehem Municipality, 2018

The above numbers reflect total number of tourists and buses, with no distinction between one-day or multiple-day visits, since data at this level of details is not available. In general, most foreign visitors in Bethlehem come as day visitors, spending here just a few hours, including a visit to Manger Street, the Nativity Church, a short trip to Shepherds' Field and souvenir shops<sup>12</sup>. In general, many touristic attractions are overlooked and there is no coherent vision or an integrated approach for tourism and mobility related provisions for tourists are generally missing in the area (e.g. there are no touristic internal buses, pedestrian tours, properly signalled walking routes, etc.).

**Car ownership levels and trends**

Car ownership levels in Palestine have been increasing in the last decade, contributing to an increased level of congestion, harmful emissions, being directly related also to the steep increase of population. Data shows that the number of registered vehicles that are using Palestinian roads has almost tripled in the last 10 years (Figure 9). In general, the number of used, second hand vehicles that are registered is much higher (70% of the total number in Q2 2016 and more than 83% in Q1 2017) than the number of new ones, creating environmental concerns and contributing to the ageing of the fleet.

**Figure 9.** Registered vehicles by year in Palestine (without Gaza Strip)



Source: PCBS<sup>13</sup>

<sup>12</sup> Dar Al-Kalima College, *SUSTAINABLE TOURISM DEVELOPMENT PLAN FOR BETHLEHEM'S OLD CITY*, (2015)

<sup>13</sup> PCBS, *Main Indicators of Transportation and Communications in Palestine for the years: 2004 – 2016*, (2018), Available at: [http://www.pcbs.gov.ps/Portals/\\_Rainbow/Documents/Trans\\_Time%20seri\\_2016e.htm](http://www.pcbs.gov.ps/Portals/_Rainbow/Documents/Trans_Time%20seri_2016e.htm)

**Table 10.** Number of newly registered vehicles in Palestine in Q2 2016 and Q1 2017

	Vehicles from international market (new)	Vehicles from international market (used)	Vehicles from the Israeli market (used)	Total
Apr-16	663	1,432	165	2,260
May-16	763	1,802	144	2,709
Jun-16	802	1,463	176	2,441
<b>Total</b>	<b>2,228</b>	<b>4,697</b>	<b>485</b>	<b>7,410</b>
Jan-17	579	3,130	355	4,064
Feb-17	545	2411	379	3335
Mar-17	565	1,828	235	2,628
<b>Total</b>	<b>1,689</b>	<b>7,369</b>	<b>969</b>	<b>10,027</b>

Source: MAS, PCBS, PMA, PCMA, 2016<sup>14</sup> and MAS, PCBS, PMA, PCMA, 2017<sup>15</sup>

As presented in the report prepared for Phase I: Data Collection of the Mobility Study, number of cars per household (derived from the household survey) in the study area is about 0.46, with a resulting number of approximately 11,600 vehicles (with higher share in urban areas than in sub-urban/ rural and camps). Distribution of vehicles per locality can be seen in **Table 11**.

**Table 11.** Number of households and estimated vehicles per locality in the study area

Locality name	Average Number of cars per household	Estimated Number of Households	Estimated number of cars per locality
Bethlehem	0.48	7,950	3,816
Beit Sahur	0.66	3,891	2,568
Beit Jala	0.46	3,700	1,702
Al Khadr	0.32	2,460	787
Ad Doha	0.49	3,069	1,504
Artas	0.37	922	341
Ad Duheisha Camp	0.25	2,749	687
Ayda Camp	0.40	522	209
Al 'Aza Camp	0.12	321	39
<b>Total/ average</b>	<b>0.46</b>	<b>25,584</b>	<b>11,653</b>

Source: CDG/ARIJ, 2017<sup>16</sup>

By analysing the numbers and the trends in Bethlehem and Palestine, it can be assumed that car ownership levels will continue to increase at a high pace, in the BAU scenario.

<sup>14</sup> MAS (Palestine Economic Policy Research Institute), PCBS, PMA (Palestine Monetary Authority), PCMA (Palestine Capital Market Authority), *Economic Monitor, issue 46*, (Ramallah: Palestine, 2016), p. 16

<sup>15</sup> MAS (Palestine Economic Policy Research Institute), PCBS, PMA (Palestine Monetary Authority), PCMA (Palestine Capital Market Authority), *Economic Monitor, issue 49*, (Ramallah: Palestine, 2017), p. 17

<sup>16</sup> CDG/ ARIJ, *Bethlehem Mobility Study, Phase I: Data Collection. Final Report*, (Bethlehem: Palestine, 2017), p. 46

### **Conclusions**

As presented above, population has been steadily increasing in Palestine and in the study area, with the population under 30 representing approximately 70% of the total. At the same time, car ownership levels and number of cars on the streets, in general, have also been increasing. Economic development, on the other hand, has been volatile and fluctuating, with high levels of unemployment and an uncertain trend in GDP growth. All these factors will have a great impact on traffic and mobility in the next decades and they will need to be carefully considered for the future of mobility in Bethlehem area.

### 3.3 Urban form and structure of Bethlehem conurbation

The urban form of a city in general is defined as the physical characteristics and spatial pattern of human activities at a certain point in time that make up the built-up areas, including the shape, size, density, split in neighbourhoods, distribution of people and historical development<sup>17,18</sup>. This section will describe the following elements: density, shape, size, distribution of people, historical development, land use, distribution of amenities and activities. The transport infrastructure and system are key elements of urban form and they will be discussed in the subsequent chapters.

The study area consists of the five different municipalities of Bethlehem, Beit Jala, Beit Sahur, Ad Doha and Al Khader, the village of Artas, and the three refugee camps. **Table 12** shows the division of the land between the different municipalities and camps, their population in 2016 and the population density.

The largest municipality in terms of land area is Al Khader, with the three camps having a very limited space. In terms of population density (**Map 2**), the densest area is 'Ayda Camp with 33,110 persons per km<sup>2</sup>, followed by Ad Duheisha Camp with a population density of about 10,995 persons per km<sup>2</sup>. The camps are the most densely populated areas due to the high population number and the smallest land area. Al Khader, on the other hand, has the lowest population density with about 618 persons per km<sup>2</sup> mainly because most of its land is not residential and people are concentrated in a small area. In general, the high population density in all localities is generated by the reduced availability of land. Due to the political situation and the division of land in areas A, B and C the cities are limited in their expansion.

The responsible authorities for issuing a building permit differ according to the classification of the area. The following are the responsible authorities for issuing the building license in each type of area: Area A – local municipalities, Area B – Ministry of Local Government, Area C – Israeli Civil Administration. Since it is not easy to get a building permit from the Israeli Civil Administration, expanding in the area C is nearly impossible.

**Table 12.** Area, population and population density

Locality	Area (km <sup>2</sup> )	Area under study (km <sup>2</sup> )	Population 2016	Density (persons/km <sup>2</sup> )
<b>Bethlehem</b>	10.6	6.0	31,799	2,997
<b>Beit Jala</b>	13.0	6.7	15,644	1,203
<b>Beit Sahur</b>	6.9	6.9	15,565	2,256
<b>Ad Doha</b>	2.1	2.1	12,275	5,845
<b>Al Khadr</b>	19.9	3.0	12,301	618
<b>Artas</b>	4.3	1.7	4,610	1,072
<b>'Ayda Camp</b>	0.1	0.1	3,311	33,110
<b>Ad Duheisha Camp</b>	1.0	1.0	10,995	10,995
<b>Al 'Aza Camp</b>	0.2	0.2	1,924	9,620

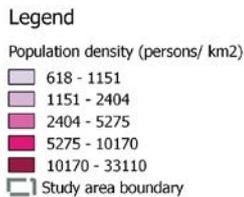
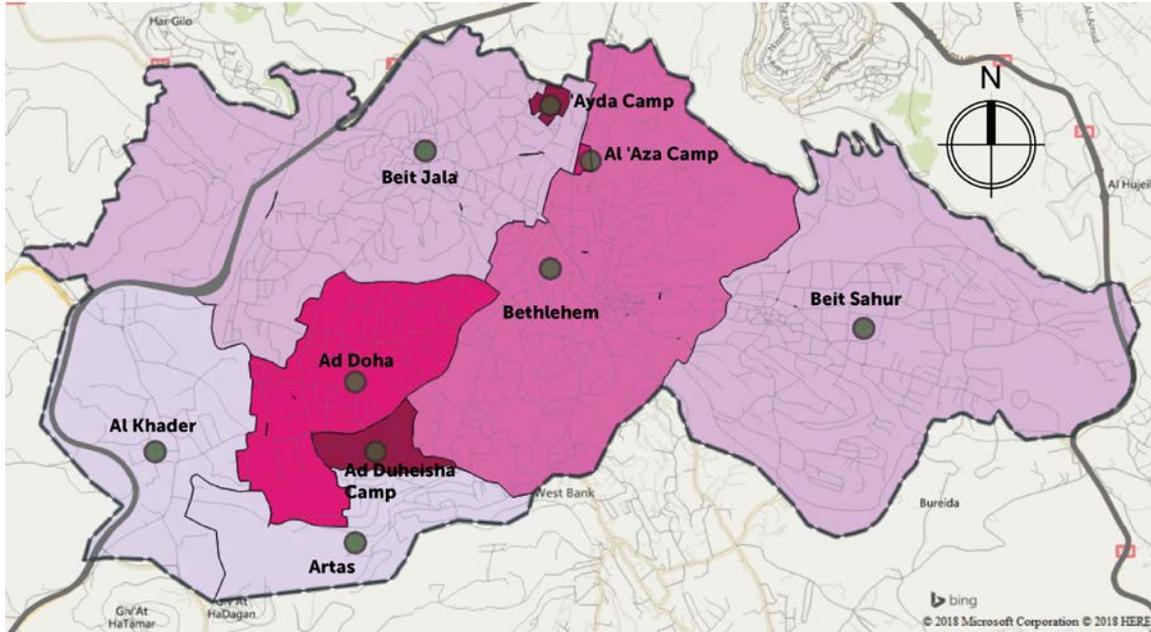
Source: PCBS and CDG/ARIJ, 2017<sup>19</sup>

<sup>17</sup> RTPI Royal Town Planning Institute, *Urban Form and Sustainability*, RTPI Research Briefing No.9 (2015)

<sup>18</sup> Anderson, W. P., Kanargoglou, P. S. and Miller, E., Urban Form, Energy and the Environment: A Review of Issues, Evidence and Policy, *Urban Studies*, 33 (1996), p. 7-35

<sup>19</sup> CDG/ ARIJ (2017)

**Map 2.** Population density per locality

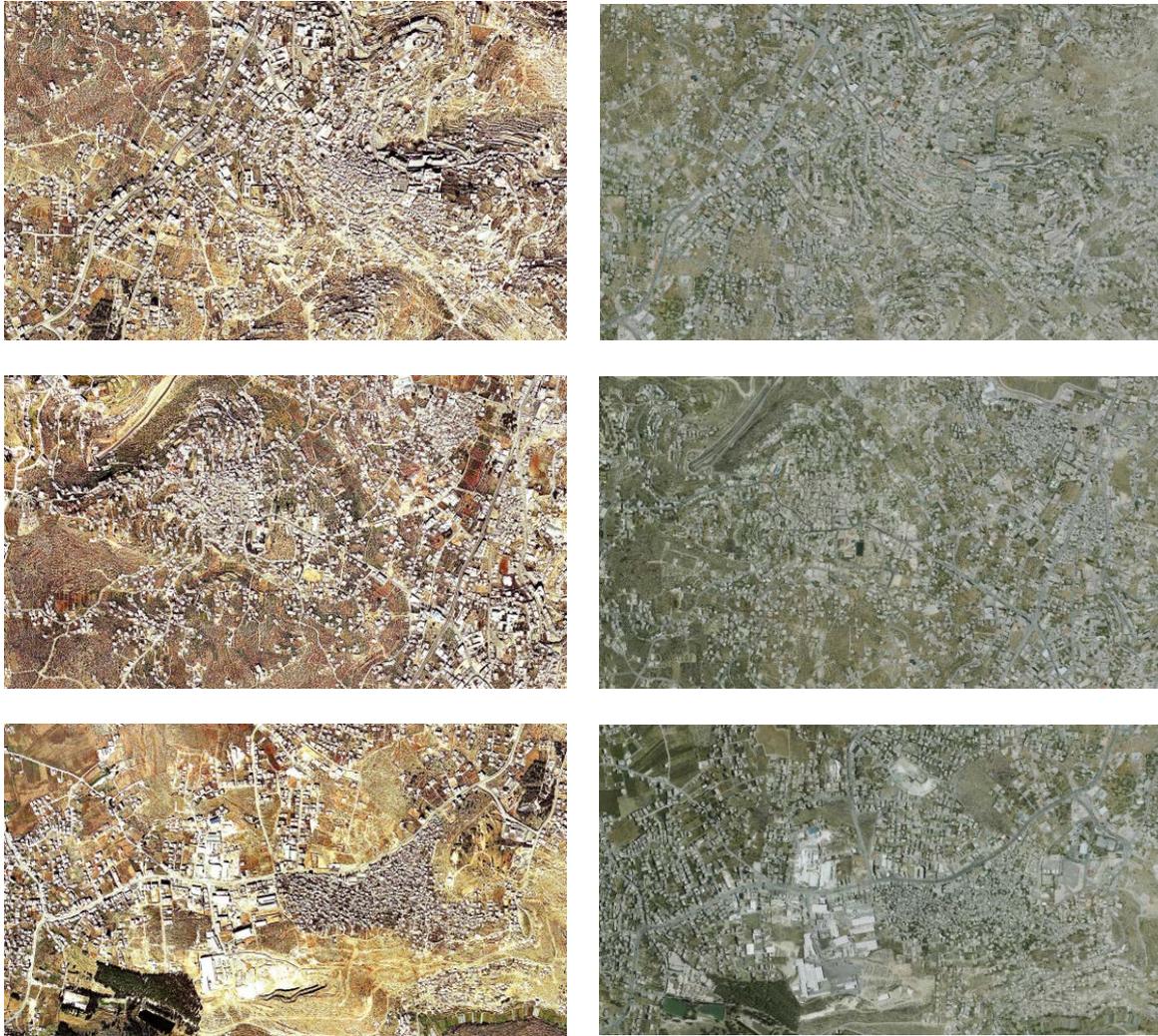


Source: PCBS data, CDG/ARIJ, 2017<sup>20</sup>

Buildings are the most apparent form of urban development. For Bethlehem conurbation due to its limited land availability and the on-going political situation, the size of the cities has decreased, while the numbers of people and buildings have increased. People used to live in small two stories high houses in the old city centre and keep the surrounding lands of the city mainly for agricultural use. But as the population increased, settlements around the cities have been constructed on the occupied land, and mainly the outer perimeter of the cities became under the control of Israeli Authorities. The inhabitants of Bethlehem area had to use any available land under the Palestinian Authorities jurisdictions to build in order to accommodate the growing population. **Map 3** shows three parts of the Study Area and how they changed during the last 20 years.

<sup>20</sup> CDG/ARIJ, (2017), p. 72

**Map 3.** Land development in Bethlehem area 1997 and 2016

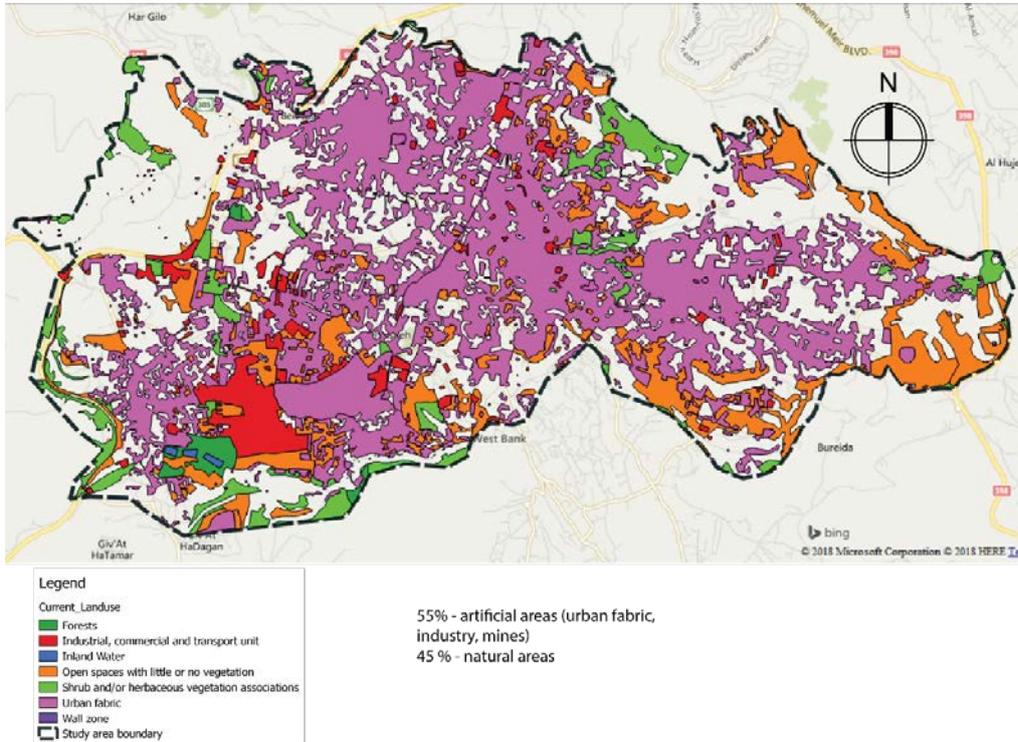


Source: Google Earth

In terms of land use, the biggest part of Bethlehem conurbation that is under study is represented by urban fabric, forming about 36% of its total area. Following with 26% is the land used for permanent crops. The land use in the study area can be seen in **Map 4**, which shows mostly the artificial areas (representing around 55% of the total surface – including buildings, roads, industrial sites, mines, etc.) and the natural areas (forests, water). The areas not represented on the map are agricultural and crop lands. **Table 13** and **Table 14** show the distribution of various uses of the land in the study area (detailed land use information from the master plan was not available for Ad Doha).

From analysing the map and the tables, it is obvious that the study area suffers from a lack of natural land, which can be used for leisure, recreation, resources, contributing to increasing the quality of life of inhabitants. 72% of the land in the study area is residential, 9.3% is reserved for future development, while only 0.2% of the total area is public space. Therefore, Bethlehem area needs to find its strong points and its opportunities in other areas, such as improving public space, creating urban green oasis, encouraging walking (see section 3.8).

**Map 4.** Land use in the study area



Source: various

**Table 13.** Land cover in Bethlehem area, using CORINE level 2 classification

Type	Area (Donum)	% from Total Area
<b>Arable land</b>	1,808	6.7%
<b>Artificial non-agricultural vegetated areas</b>	35	0.1%
<b>Forests</b>	191	0.7%
<b>Heterogeneous agricultural areas</b>	2,255	8.3%
<b>Industrial, commercial and transport unit</b>	1,032	3.8%
<b>Inland Water</b>	31	0.1%
<b>Mine, dump and construction sites</b>	400	1.5%
<b>Open spaces with little or no vegetation</b>	3,251	12.0%
<b>Permanent crops</b>	6,930	25.5%
<b>Plastic Houses</b>	33	0.1%
<b>Shrub and/or herbaceous vegetation associations</b>	1,233	4.5%
<b>Urban fabric</b>	9,852	36.3%
<b>Wall zone</b>	127	0.5%
<b>Total Area</b>	<b>27,176</b>	<b>100.00%</b>

Source: CDG/ARIJ, 2017<sup>21</sup> and municipalities

<sup>21</sup> CDG/ARIJ, (2017), p. 28

**Table 14.** Land use in the built-up urban areas

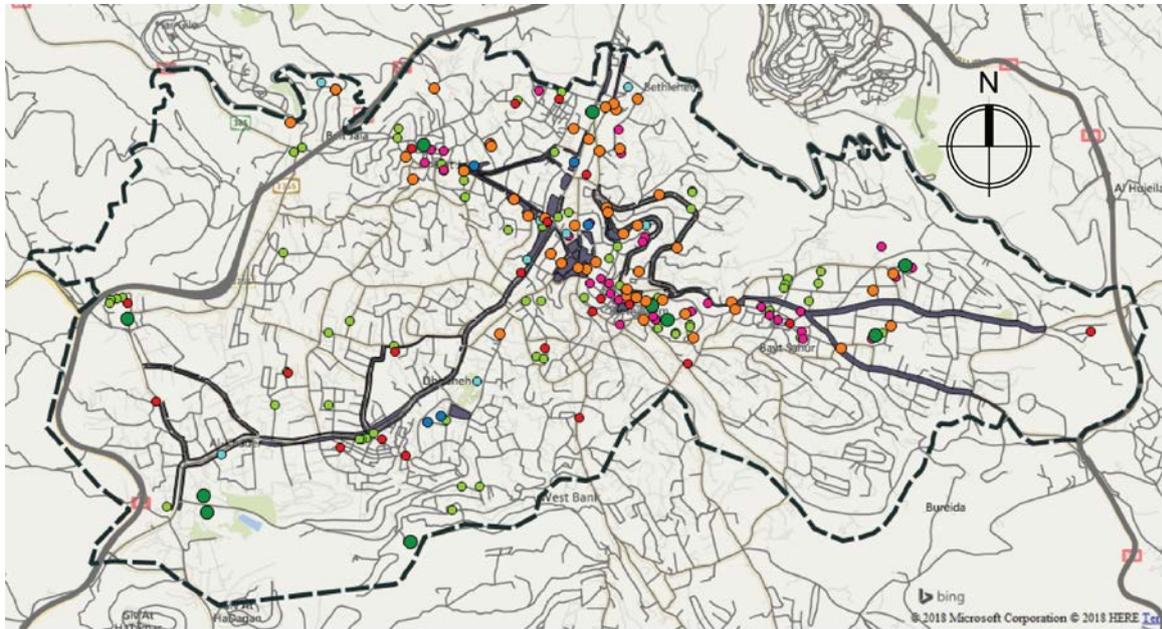
Land use	Area Dunum	% of total
<b>Residential</b>	15,020	72.1%
<b>Commercial</b>	712	3.4%
<b>Industrial</b>	171	0.8%
<b>Old City</b>	530	2.5%
<b>Public Garden</b>	39	0.2%
<b>Cemetery</b>	45	0.2%
<b>Roads</b>	1,200	5.8%
<b>Green Area</b>	1,174	5.6%
<b>Area for Future Development</b>	1,935	9.3%
<b>Total</b>	<b>20,826</b>	<b>100.00%</b>

Source: CDG/ARIJ, 2017<sup>22</sup> and municipalities

Going into more details, it is important to also understand the location of the main attraction, facilities and amenities in the study area. **Map 5** shows the locations, the distribution and the density of: schools, universities, hospitals, religious places, hotels, commercial areas and touristic sites (heritage sites), in relation with the road network. From the map it can be concluded that there are various locations with a high concentration of amenities, which consequently attract and produce a lot of traffic. These are, for example, the city centre of Bethlehem, Manger Street, Al Al Sahel Street in Beit Jala, the city centre of Beit Sahur. These are the most delicate areas in terms of traffic, as well and they will need careful consideration.

<sup>22</sup> CDG/ARIJ, (2017), p. 29

**Map 5.** Bethlehem area and its amenities distribution



- Legend**
- Schools
  - Universities
  - Mosques
  - Churches
  - Hotels
  - Hospitals
  - Heritage\_Sites
  - Commercial\_Areas
  - Road network
  - Israeli controlled roads (higher capacity and speed)
  - Study area boundary

Source: Own, based on ARIJ database

### Conclusions

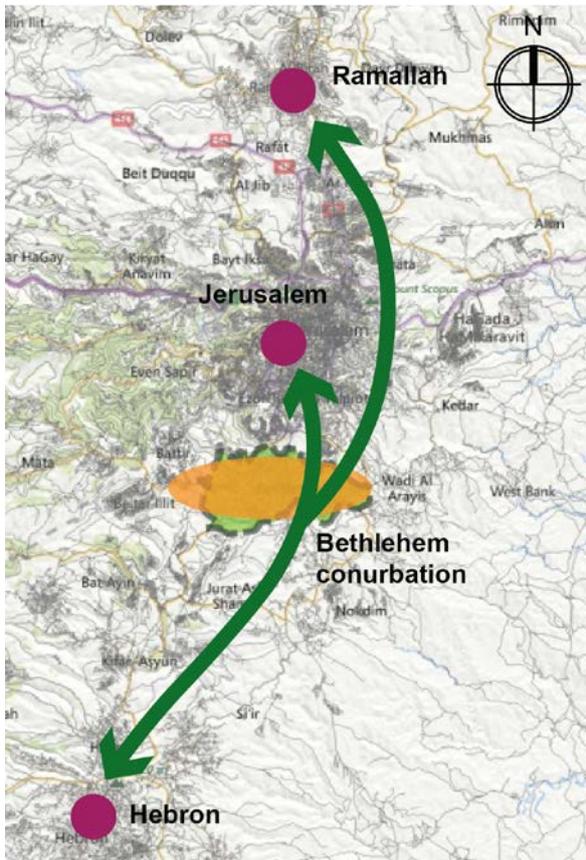
Given the limited area available for development, the population growth and other internal and external factors, there is a tension and a fight for space. Mobility and infrastructure, if not planned properly have a high space demand. On the other hand, Bethlehem presents a high density of amenities and facilities, within a short (walkable) distance, which is an opportunity for further developing the infrastructure and the transport system.

### 3.4 The regional position of Bethlehem conurbation

Bethlehem conurbation has a strategic location in the region, being placed in the south of Jerusalem, connecting the north and the south of the West Bank (*Map 6*). Thus, Bethlehem is a key location linking Hebron, in the south with Ramallah, Jericho and other important urban areas in the north. As Hebron is one of the biggest industrial governorates, Bethlehem witnesses a great deal of through traffic due to the absence of bypass roads. The through traffic uses the main roads of Bethlehem conurbation, causing disruptions, delays and incidents. This topic will be further and more in details discussed in the following sections and once the model output is processed.

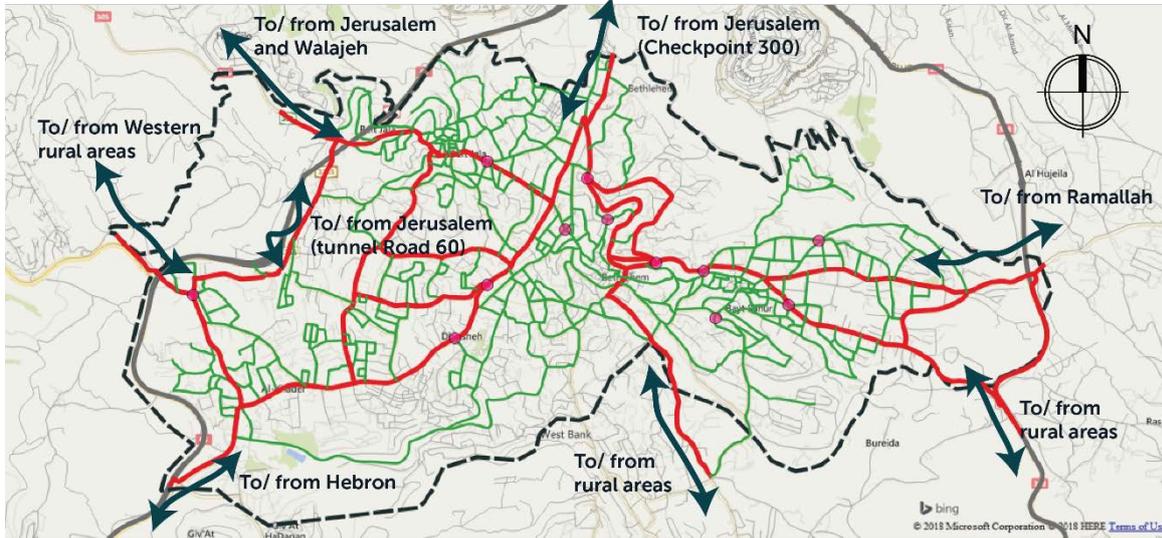
In terms of economic importance, Bethlehem conurbation is neither industrial nor the centre of the governmental institutions in Palestine. Its economic importance is mainly due to tourism, as more than 20% of the working population is employed in this sector<sup>23</sup>. Bethlehem is the main touristic attraction area in Palestine due to its holy status. Handicraft industry like mother-of-pearl and olive wood are main part of the conurbation's economy. Other industries like textile and stone factories compromise a small part of its economy.

*Map 6. Regional position of Bethlehem area*



<sup>23</sup> <http://www.bethlehem-city.org/en/the-city-economy>, (2014)

**Map 7.** Entry/ exit points in Bethlehem area



**Conclusions**

Bethlehem is situated in a strategic regional position, at a crossroad between north and south of Palestine. Because of this, the road network of Bethlehem area is used by traffic that is serving external areas, such as Ramallah or Hebron, suffering from congestion and delays caused by this through traffic.

### 3.5 Climate change and environmental challenges in Palestine and Bethlehem conurbation

#### *Climate change in Palestine*

Negative impacts of climate change can already be seen in Palestine in general and in Bethlehem in particular. In recent years, the country has experienced increased temperature (a positive trend 0.09[0.07-0.11] °C/ decade), especially during the summer, heat waves with a higher intensity, length and frequency, an increase of the number of warm days and nights and decrease of the number of cold days and nights, high variability in rainfalls, etc.<sup>24</sup>

Being a party to the United Nations Framework Convention on Climate Change (UNFCCC) since March 2016 and a signatory of the Paris Agreement in April 2016, Palestine has acknowledged the risks posed by climate change and has committed to the objectives of the Convention. Palestine has committed to become an active player in tackling and responding to climate change, by not only adopting adaptation measures, but also by stabilizing its GHG emissions, aiming at limiting its impact on climate, biodiversity and nature, in general. According to its NDC (Nationally Determined Contributions) Palestine has committed to reduce its CO<sub>2</sub>eq. emissions with at least 12.8 % compared to the Business as Usual Scenario (BAU) by 2040, in the status quo scenario or with at least 24.4%, if it achieves independence.<sup>25</sup>

#### *Emissions levels in Palestine*

Emissions of GHG from human activities have been recognised as the main observed driver of climate change<sup>26</sup>. Moreover, like in most countries around the world, the transport sector in Palestine accounts for a large share of the GHG and other harmful emissions and is a main source of air pollution, being a major culprit for climate change. This is due mainly to the population growth, annual growth of vehicle fleet (as shown above in **Figure 9**), the large share of second-hand, old vehicles without a catalyser and the emission standards set for vehicles, fuel quality standards, traffic management and general travel patterns (share of transport modes).<sup>27</sup> Thus, the transport sector is annually responsible for large quantities of hazardous gases such as carbon monoxide (CO), nitrogen oxides (NO<sub>x</sub>), sulphur oxides (SO<sub>x</sub>) and hydrocarbons (HC), as well as other harmful substances, such as particulate matters (PM), dust, etc.<sup>28</sup>

In general, the concentration and production of each pollutant depends on the type of fuel and the type of vehicle. Diesel is promoted as a more environmentally friendly fuel specially to reduce carbon dioxide (CO<sub>2</sub>). Diesel engines use less fuel and more air to get the same performance as a petrol engine. Although diesel fuel contains slightly more carbon (2.66kg CO<sub>2</sub>/litre) than petrol (2.29kg CO<sub>2</sub>/litre), general CO<sub>2</sub> emissions of a diesel car tend to be lower<sup>29</sup>. In use, on average, this equates to around 200g CO<sub>2</sub>/km for petrol and 120g

<sup>24</sup> ARIJ Applied Research Institute Jerusalem, *Status of The Environment in the State of Palestine*, (Bethlehem: Palestine, 2015), p. 130 - 133

<sup>25</sup> State of Palestine, Nationally Determined Contributions, United Nations Framework Convention on Climate Change (UNFCCC), (2016). Available at: <http://www4.unfccc.int/ndcregistry/PublishedDocuments/State%20of%20Palestine%20First/State%20of%20Palestine%20First%20NDC.pdf>

<sup>26</sup> IPCC Intergovernmental Panel on Climate Change, *Climate change 2013: The physical science basis. Working Group I contribution to the IPCC Fifth Assessment Report*. (Cambridge: Cambridge University Press, 2013). Available at: [www.ipcc.ch/report/ar5/wg1](http://www.ipcc.ch/report/ar5/wg1).

<sup>27</sup> ARIJ, *Status of The Environment*, p. 112

<sup>28</sup> EEA European Environment Agency, *Horizon 2020 Mediterranean report, Annex 5: Palestine*, (Luxembourg, 2014)

<sup>29</sup> Ministry of Natural Resources Canada, *Learn the facts: Fuel consumption and CO<sub>2</sub>*, (2014). Available at: [http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/oeef/pdf/transportation/fuel-efficient-technologies/autosmart\\_factsheet\\_6\\_e.pdf](http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/oeef/pdf/transportation/fuel-efficient-technologies/autosmart_factsheet_6_e.pdf)

CO<sub>2</sub>/km for diesel<sup>30</sup>. On the other hand, other harmful substances and greenhouse gases, such as NO<sub>x</sub> are produced in much higher quantities by diesel engines.

In 2014, the PCBS presented the total emission of CO<sub>2</sub> (**Table 16**) from different types of vehicles and fuels. Passengers vehicles that use diesel and gasoline have approximately the same amount of CO<sub>2</sub> emissions. This is clearly reflected also in the age of the vehicle fleet.

**Table 15.** Total CO<sub>2</sub> produced (Tons) by Vehicle Type and Region, 2014

Region /Type of fuel and vehicle	Gasoline				Diesel			
	Passenger vehicles	Goods vehicles	Other vehicles	Total	Passenger vehicles	Goods vehicles	Other vehicles	Total
Palestine	801,234	27,676	2,711	831,621	978,624	987,046	46,670	2,012,340
West Bank	493,403	4,887	1,329	499,619	755,599	659,886	26,682	1,442,167
North of West Bank	172,276	2,622	620	175,518	298,693	172,051	14,212	484,956
Middle of West Bank	190,551		236	190,787	239,342	289,351	5,465	534,158
South of West Bank	130,576	2,265	473	133,314	217,564	198,484	7,003	423,051
Gaza Strip	307,831	22,789	1,382	332,002	223,025	327,160	19,988	570,173

Source: PCBS (2018)<sup>31</sup>

The “Euro standards” regulate emissions of nitrogen oxides (NO<sub>x</sub>), hydrocarbons (HC), carbon monoxide (CO), particulate matter (PM), and particle numbers (PN). There are separate regulations for light vehicles (under 3.5 tonnes) and heavy-duty vehicles. In **Table 15** the evolution of the regulations is presented.

**Table 16.** Emission standards for passenger cars in mg/km

	CO		HC+NO <sub>x</sub>		PM	
	Diesel	Gasoline	Diesel	Gasoline	Diesel	Gasoline
Euro 1 - July/1992	272	272	970	970	140	-
Euro 2 - January/1996	100	220	700	500	80-100	-
Euro 3 - January/2000	660	230	560	-	50	-
Euro 4 - January/2005	500	100	300	-	25	-
Euro 5 - September/2009-2011	500	100	230	-	5	5
Euro 6 - September/2014	500	100	170	-	5	5

Source: AirClim, 2012<sup>32</sup>

<sup>30</sup> Paul Nieuwenhuis & Aonghus McNabola, *Fact Check: are diesel cars really more polluting than petrol cars?* (Cardiff: Cardiff University, 2017). Available at: <https://theconversation.com/fact-check-are-diesel-cars-really-more-polluting-than-petrol-cars-76241>

<sup>31</sup> PCBS, *Total CO<sub>2</sub> produced (Ton) by Fuel Type, Vehicle Type and Region, 2014*, (2018), Available at: [http://www.pcbs.gov.ps/Portals/\\_Rainbow/Documents/ENTS%20Tables%20E19%202014.htm](http://www.pcbs.gov.ps/Portals/_Rainbow/Documents/ENTS%20Tables%20E19%202014.htm)

<sup>32</sup> AirClim, Air Pollution and Climate Secretariat, *Emission standards for light and heavy road vehicles*, (2012), Available at: <http://www.airclim.org/sites/default/files/documents/Factsheet-emission-standards.pdf>

Although climate change is a global problem, solutions should be sought and implemented locally. Thus, by approving and implementing its sustainable mobility plan, Bethlehem would become an example and a leader in mitigation and adaptation to climate change through sustainable planning. In the study “State of Palestine. NDC”, urban transport has been identified as a sector with a high potential for climate change mitigation, through various possible measures:

- » Encouraging the use of public transport, in addition to bus rapid transport.
- » Improve the efficiency of the road vehicles by updating the vehicle fleet, disposing of old vehicles, and promoting and encouraging the use of efficient vehicles.
- » Reduce traffic jams.
- » Use multi-modal transport patterns.
- » Control the technical condition of vehicles and periodic maintenance to improve fuel efficiency and reduce emissions.

These are principles and measures that would be further considered in the planning process.

It is important to highlight that the Palestinian government has already set some measures to improve the quality of their fleet. In March 2009 the Customs and Taxes for new cars were reduced from 75% to 50% for petrol cars, 30% for hybrid cars, and only 10% for electric cars<sup>33</sup>. This arrangement was implemented to reduce the prices of new cars to encourage people to replace their old vehicles with new ones and therefore reduce on road emissions, specially from CO<sub>2</sub>, the main transport GHG pollutant. These new vehicles will not only have an effect on the reduction of CO<sub>2</sub> but also on other pollutants such as PM<sub>10</sub> that cause severe health problems such as aggravation of asthma and increase mortality from cardiovascular and respiratory diseases and from lung cancer<sup>34</sup>.

### Conclusions

The low quality of the vehicle fleet, with more than half of the vehicle being second hand, Palestine and Bethlehem are suffering from environmental problems caused by traffic. On the other hand, as it is the case with many developing economies, also Palestine is facing the challenge of balancing development and fulfilling demands of international climate agreements, such as Paris Agreement.

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<sup>33</sup> Ali Shaath and Naser Abu Sharbak, *Permitted Road Transport Specific Emissions of CO<sub>2</sub> in Palestine* (Ramallah: Palestine, 2010).

<sup>34</sup> WHO World Health Organisation, *Health effects of particulate matter* (2014).

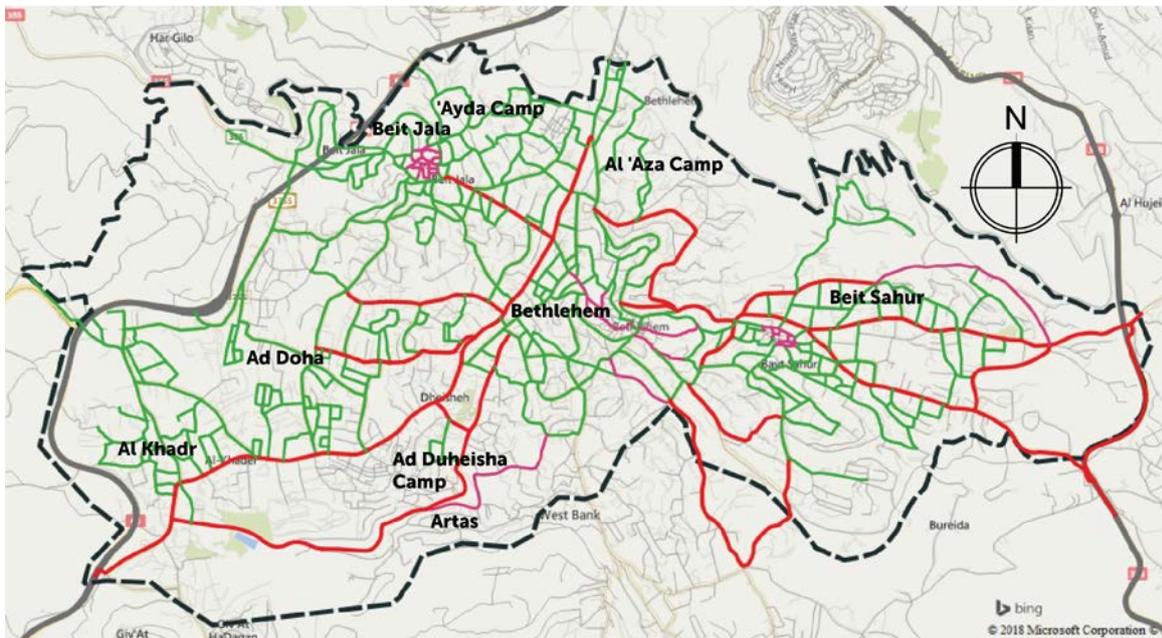
Available at: [http://www.euro.who.int/\\_\\_data/assets/pdf\\_file/0006/189051/Health-effects-of-particulate-matter-final-Eng.pdf](http://www.euro.who.int/__data/assets/pdf_file/0006/189051/Health-effects-of-particulate-matter-final-Eng.pdf).

### 3.6 Road network

#### Major vehicle infrastructure characteristics

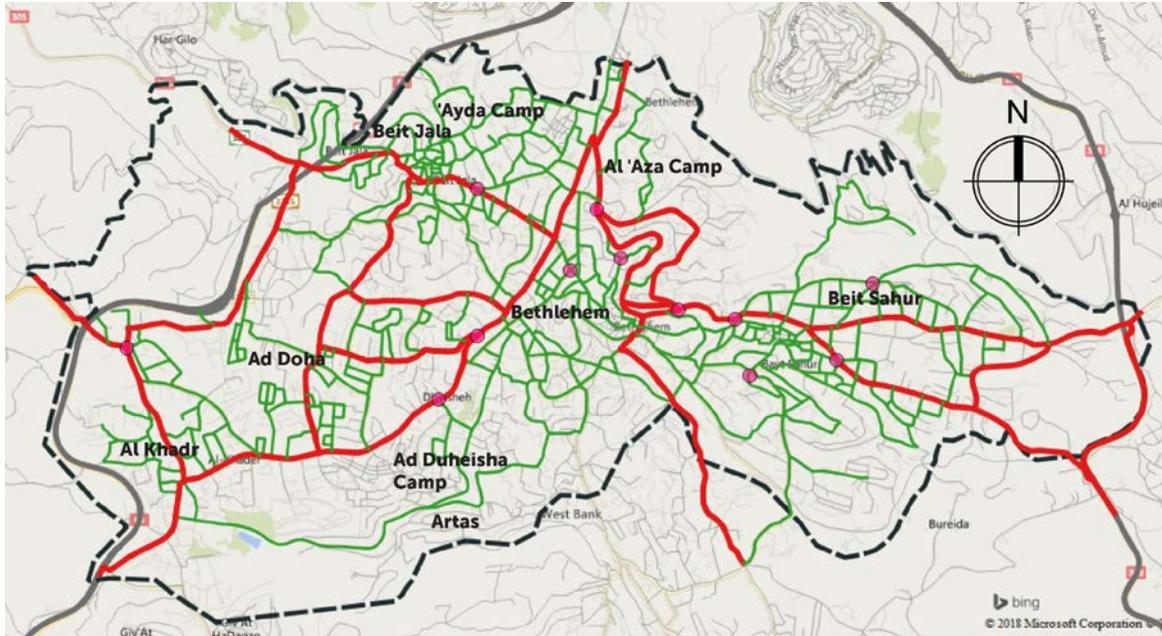
The road network in the Bethlehem conurbation is a complex one, without a clear categorisation or structure – there is no radial or circular structure defining main routes. The main routes are determined by major traffic attractors and producers, such as Bethlehem city centre, Beit Jala commercial area, Beit Sahur city centre, schools, heritage sites, and major commercial / leisure areas. The roads serve different functions within the conurbation of Bethlehem – connectors of major urban, semi-urban and rural settlements, access roads, sojourning, serving main commercial locations, etc. At the same time, since there is no external ring road (especially due to Israeli imposed restrictions of usage of highways and main roads), all types of traffic are using the same network – internal, external and through traffic. The speed and the capacity of the roads differ and the network is not uniform, with major four-lane roads discharging directly in city streets, with a much lower capacity. The legal speed on different roads is established by the Traffic Law nr. 5 from 2000 and is presented in **Map 8**.

**Map 8.** Legal speed on the roads, stipulated in the Traffic Law nr. 5 from 2000



- Legend
- Legal speed on roads
- 20 - 29 km/h
  - 30 - 49 km/h
  - 50 - 60 km/h
  - Israeli controlled roads (higher capacity and speed)
  - Study area boundary

**Map 9.** Road categorisation and main roundabouts in the study area



**Legend**

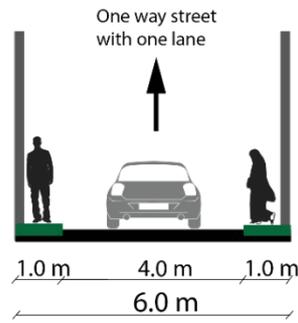
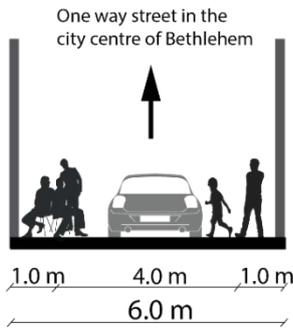
- Main roundabouts
- Road category
  - Main roads
  - Secondary roads
  - Residential/ tertiary roads
  - Israeli controlled roads (higher capacity and speed)
  - ▭ Study area boundary

Source: CDG/ARIJ, 2017<sup>35</sup>

With some exception (for example the road around Beit Jala city centre), most of the roads marked as “main roads” in **Map 9** have a wide profile, with two lanes for each direction and a variable width pavement. The typical profiles of roads in Bethlehem conurbation will have a width of 6.0, 8.0 m, 10.0 – 12.0 m and 16.0 – 18.0 m, with local and punctual variations, especially regarding the width of pavement and the usage of the existing sections (mixed for parking and driving, exclusively driving, with parking forbidden, etc.).

<sup>35</sup> CDG/ ARIJ, (2017), p. 48

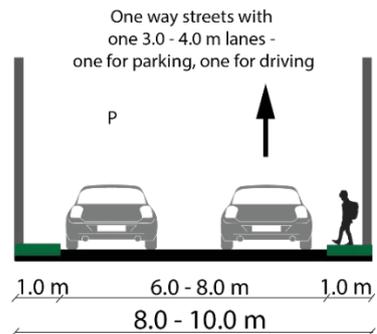
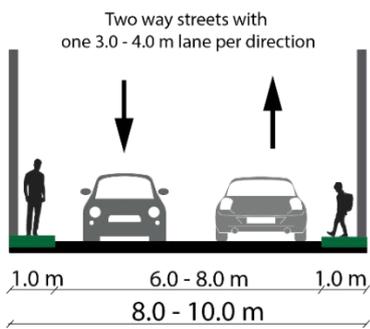
Figure 10. Typical street profiles in the study area



Star Street, Bethlehem



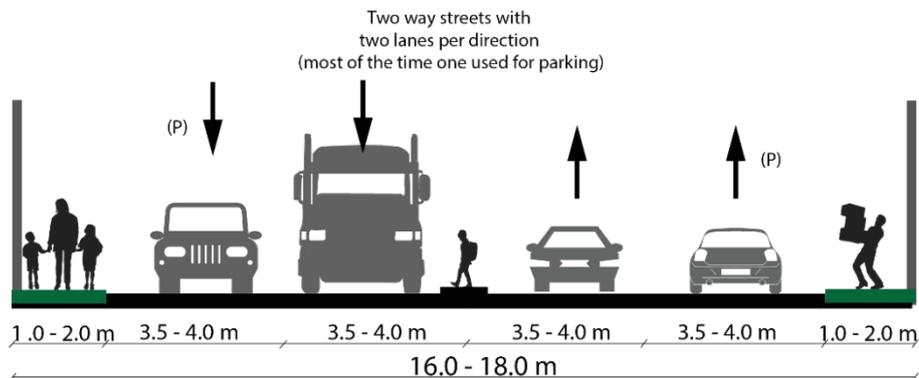
Manger Street, Bethlehem



Children Street, Bethlehem



Manger Street, Bethlehem



Jerusalem - Hebron Road , Bethlehem



Al Al Sahel Street

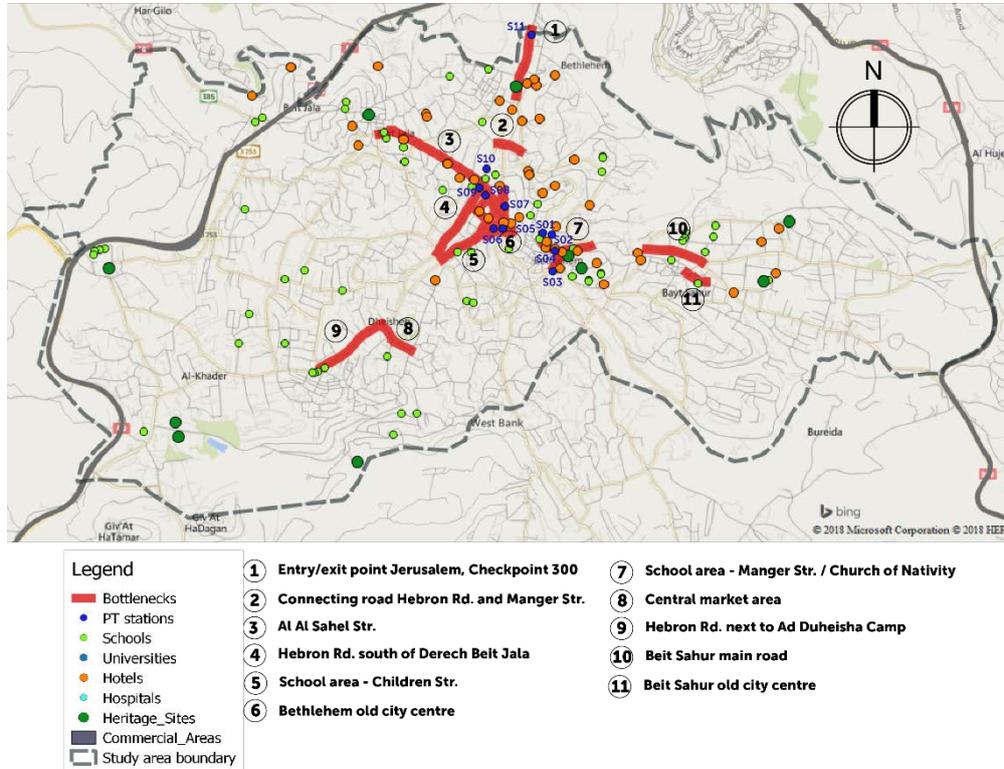
### **Bottlenecks and main dysfunctionalities**

The major bottlenecks and disruptions in the major road network in the Bethlehem conurbation are concentrated in specific areas, but there are no systemic problems regarding the capacity of the major road infrastructure. The major cause of bottlenecks and disruptions are:

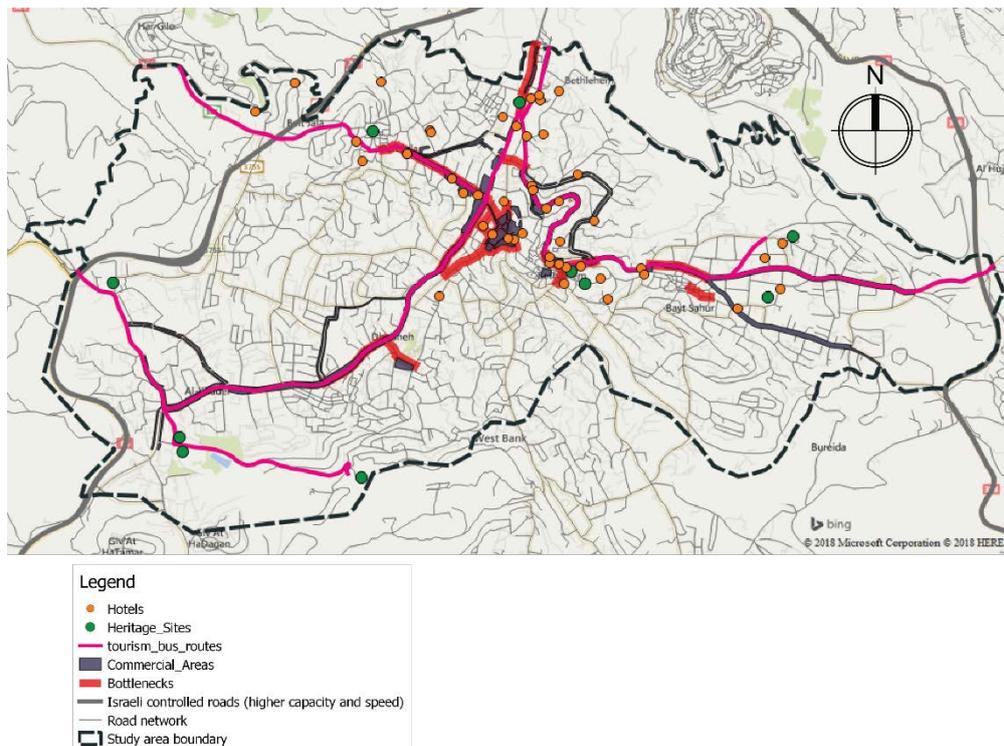
- » Faulty design of roundabouts
- » Unclear signalling or lack thereof, poor quality of pavement
- » Concentration of amenities that are producing and/or attracting traffic
- » Faulty and improper use of the street – parking in places where it is not permitted, double, sometimes triple parking, temporary stopping by the side of the road (for loading/ unloading, shopping, dropping or picking children up from schools, etc.)
- » Drop-off/ pick-up points in front of hotels made by large touristic buses, both during the day and the night.

The location of the most problematic areas, in terms of traffic flow and accessibility are shown in **Map 10**. As mentioned also in Chapter 0, touristic buses also pose challenges to road traffic in Bethlehem, with more than 20.000 buses per year. These buses are also using the most congested roads in Bethlehem, sharing the space with the local traffic. **Map 11** shows the touristic buses routes in the context of local amenities and local traffic bottlenecks.

Map 10. Location of main bottlenecks and disruptions on the road network



Map 11. Touristic buses routes and main bottlenecks



### Bottleneck 1 – Entry/ exit point Jerusalem, Checkpoint 300

The entry/ exit point on Hebron Road, in the north of Bethlehem is a major access point to and from Jerusalem. The roads themselves do not present capacity problems, having a section of around 20 m wide. But the delays produced by the Israeli checkpoint, the fact that this represents the main entry point for both Palestinian that live in Israel and the tourist buses, the presence of a busy bus station, S11, which serves the external bus line 30 to and from Hebron, coupled with a poor quality of the pavement and signalling, often create disruptions in the traffic flow and unsafe circulation conditions in this area.

The counts<sup>36</sup> performed during Phase I: Data Collection (CDG/ ARIJ) show that this entry/exit point accounts for about 10% of all traffic recorded at all entry/exit points on an average working day (counts were made on a Thursday, during morning peak hour 7:00 – 8:00, noon peak hour 12:30 – 13:30 and evening peak hour 16:30 – 17:30). The highest percentage of vehicles is represented by private cars, with more than 50% share of all counted traffic. It is also worth mentioning that the number of touristic buses that have been registered during the three peak hours was 21 entering and 13 exiting Bethlehem.

Furthermore, counts performed on a regular working day showed the proportion of vehicles with Israeli (yellow) and Palestinian (white) plates. Therefore, there were 273 vehicles with yellow plates and 279 with white plates exiting the study area (on a Thursday, between 7:00 – 8:00 am, 12:30 – 13:30 pm and 16:30 – 17:30 pm), but for the same periods, there were 638 Israeli vehicles and only 329 Palestinian vehicles entering the area. The people that are coming from Israel to Bethlehem are mostly Palestinians that live in Israel (or the so-called “Palestinians of 48”). These are mostly people that did not flee occupied territories during 1948, part of their families live nowadays in Palestine, either in refugee camps or in rural/ urban areas. Therefore, many of them come frequently to Palestine (including Bethlehem) to visit their relatives, especially for weddings and other family events. This creates extra traffic, but also a need for parking spaces, especially during night.

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<sup>36</sup> Note: Due to security reasons, counts could not be performed exactly at entry/ exit point (Checkpoint 300), but further away from it. This means that a proportion of the counted vehicles (approximately 20% will represent internal traffic). The numbers presented above represent not-corrected data (including internal traffic).

**Photo 1.** a) Entry/ Exit point Jerusalem (Checkpoint 300), b) Improper parking; c) PT station; d) Poor quality of road surfaces and lack of road signalling and marking



It is also worth mentioning that the problems and dysfunctions at this location are not only related to vehicles movement, but also to people crossing on foot the checkpoint, as Palestinians with permits must go through the 3 different security checks. This consumes a lot of time and creates congestion and road blockages. This congestion usually happens in the early morning peaks between 5:00 am to 6:00, when Palestinians who work in Israel go to work and in the afternoon peaks between 16:00 to 17:00, when workers return home. This crossing point is not only used by residents of the study area, but also by the inhabitants of the rural and urban areas surrounding the study area like Dar Salah, Husan and other villages. That is also the case for people coming from the southern part of Palestine, for example from Hebron.

**Photo 2.** Palestinian workers crossing Checkpoint 300 on foot



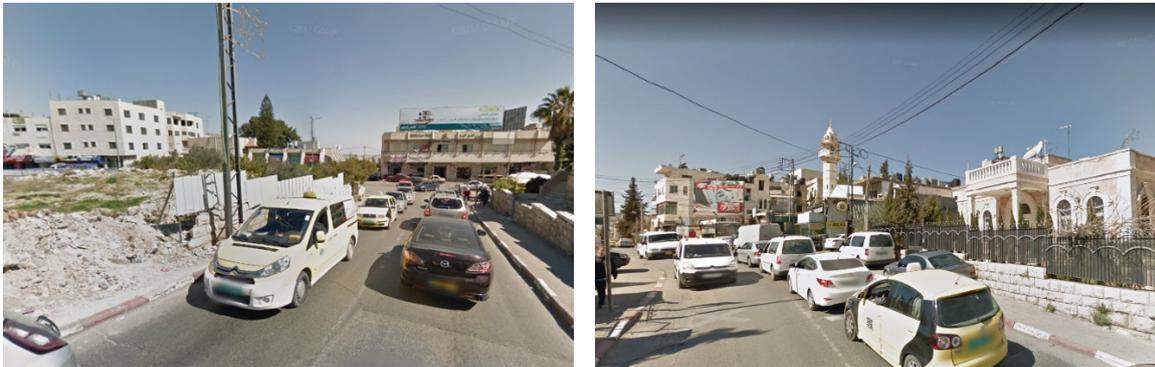
Source: <https://maannews.net/Content.aspx?id=954520>

Furthermore, there is an undocumented number of international tourists that cross the Checkpoint 300 on foot, for visiting Bethlehem. Providing some facilities for this purpose –such as an information point or a touristic bus connecting this point to attractions and main locations would improve the touristic experience in Bethlehem.

**Bottleneck 2 – Connecting road between Hebron Road and Manger Street**

This road is connecting two major arteries in the north of Bethlehem municipality. The profile of the street is 8.0 m wide, with a 3.0 m lane for each direction and a narrow pavement on both sides. Parking is not permitted on any side along this road; nevertheless temporary stops and illegal parking often cause delays and congestions. Furthermore, this road is used by the bus lines 18 and 19 (served by 4 and 7 seats shared taxis), leaving from bus station S01, in the direction of Ad Doha and Ad Duheisha Camp, respectively. On the northern side, Al ‘Aza Camp is located and it is producing traffic that discharges many times on this road.

*Photo 3. Connecting road Hebron Road and Manger Street*



**Bottleneck 3 – Al Sahel Street**

This road is one of the most important traffic links in the study area, connecting Bethlehem with Beit Jala, but also Bethlehem with Jerusalem and the Western rural areas. It is a route used by all modes, with several public transport lines passing it – internal line 15 and 16 (served by shared taxi and small buses), external lines 22, 23, 24, 25 going to rural areas (served by mostly shared taxi and some small buses) and line 37 going to Jerusalem (served by large buses). Furthermore, the street has a high concentration of commercial facilities hotels and restaurants, being a major attractor of traffic throughout the whole day. Also, along the road (towards the city centre of Beit Jala) there are various private and public schools and a university that normally have a high impact on traffic flow and congestion, since many children/ young people are dropped and picked up by either private vehicles or by shared taxis.

Most of the time, congestion and disruptions are not systemic, but incidental, caused by illegal parking and temporary faulty stops by the side of the road (for picking up, dropping off children to school, running errands at banks and shops, etc.). Also, the general capacity of the road (two lanes per direction) is halved due to parking areas (permitted parking). Just like in many other cases, poor quality of the road surface and the lack of proper signalling and marking on the road also contribute to delays and unsafe traffic situation.

**Photo 4.** Al Sahel Street – a) Illegal parking; b) Congestion during rush hour

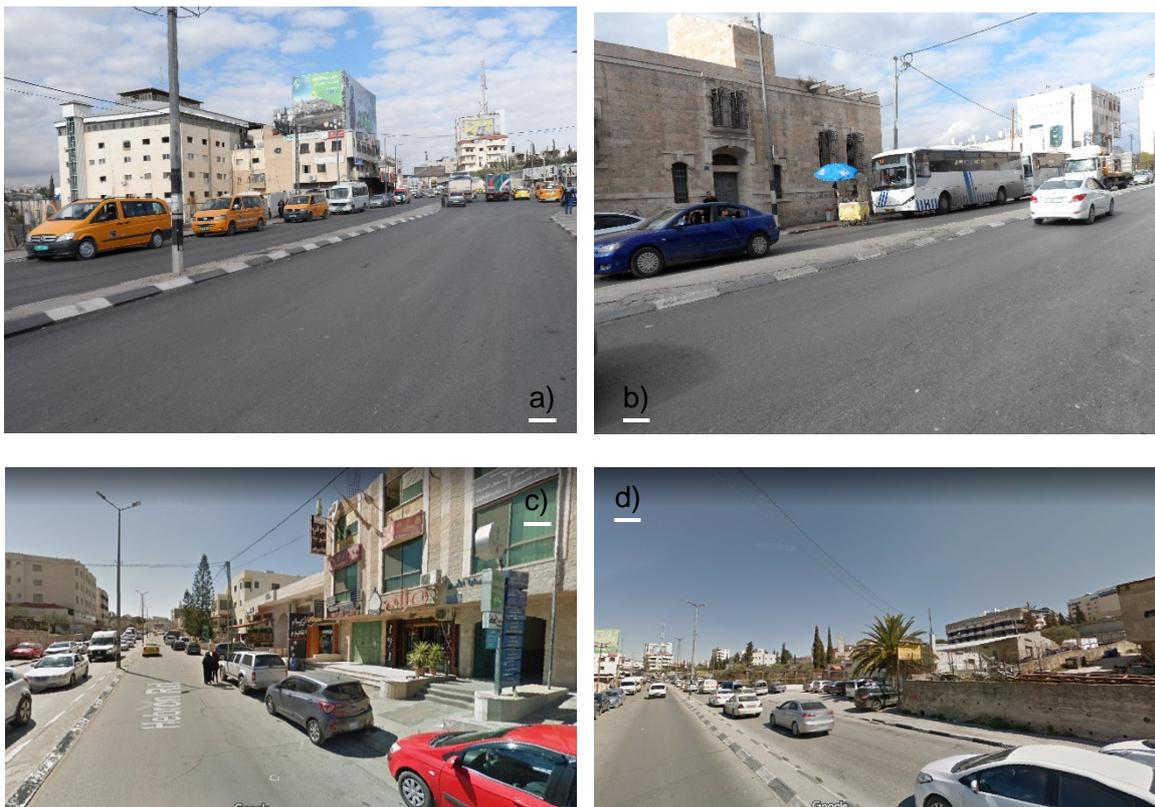


**Bottleneck 4 – Hebron Road, south of Beit Jala Street and Bottleneck 9 – Hebron Road next to Ad Duheisha Camp**

Hebron Road is a major artery of the infrastructure in Bethlehem conurbation, serving as a connecting road between Bethlehem and Ad Doha, Ad Duheisha Camp, Al Khader and further Hebron. The road section south of Beit Jala is one of the busiest and intensely used, and here, traffic participants experience many times delays, disruptions, incidents and unsafe situations. This is because in close vicinity there are two busy bus stations – S09 (located on the main road), serving line 30 to Hebron and S08, serving both internal and external routes. Various bus routes are using this section of the road: internal lines 18 and 19 going to Ad Doha and Ad Duheisha Camp, line 21 going to Al Khader, external routes 22, 23, 24 and 25 to rural areas within the Governorate, and external line 31 to Hebron.

Same is the situation in the southern section of the road, around Ad Duheisha Camp, where besides the aspects mentioned above; there is an agglomeration of commercial amenities.

**Photo 5.** Hebron Road, south of Beit Jala. a) Bus station S09; b) Mixed traffic – personal vehicles, large buses (Jerusalem Buses); c) Parking allowed on both sides of the street; d) Better quality of road surfaces, but lack of proper road signalling and marking



#### Bottleneck 5 and 7 – School areas - Children Street and Manger Street (Nativity Church)

In general, school and university areas are posing great challenges to traffic in Bethlehem conurbation. This is due to the high number of schools – there are 61 schools and 5 universities in the study area, some of them with a high number of pupils and students (as shown in the socio-economic data analysis, the school-age population accounts for approximately 40% of the total population of the Governorate).

In general, many school children (especially from private schools) are dropped off and picked up by their parents, since there are no public transport services organised for schools. Furthermore, many of the university students use shared taxis (4 and 7 seats). This creates incidental increases in traffic around school areas, during morning peak hours and noon peak hours. In many cases, vehicles stop on the road, since there are no special areas designated for pick-up/ drop-off. Furthermore, this creates unsafe traffic conditions, both drivers and pedestrians.

**Photo 6.** Congestion and unsafe traffic situation around school areas – a) Children Str.; b) Manger Str.



#### Bottleneck 6 – Bethlehem old city centre

Unlike old city centres in other countries, Bethlehem has no areas or streets that are pedestrian areas (vehicles are not allowed unless they have a special permit, or they access it during particular hours). Therefore, given the configuration of the streets (very narrow profiles of 6.0 – 8.0 m), the agglomeration of commercial amenities, the location of a university and of two busy public transport stations in this area, traffic flow is many times hindered, delayed and unsafe. Furthermore, many of the residential buildings in the city centre do not have their own parking place (inside their premises), therefore private vehicles are parked on the streets. Stations S05 and S06 for shared taxis, serving external routes going to rural areas within Bethlehem Governorate are also creating increased traffic influx.

**Photo 7.** Bethlehem city centre – a) Parking of residents; b) Street used by pedestrians and vehicles



**Bottleneck 8 – Central market area**

The area around the central market, located in the south of Bethlehem, close to Hebron Road is generally a busy area, due to a concentration of commercial amenities, two universities and various public institutions (like the City Courthouse, the Public Library). All these facilities produce and attract traffic, creating bottlenecks and travel delays. Internal bus lines 20 and 21 also use this road. Furthermore, as with many other streets, the quality of the surface is poor and there is no traffic marking and signalling.

**Photo 8.** Central market area



**Bottleneck 10 – Beit Sahur main road**

The road that goes through Beit Sahur is one of the main entry and exit points in Bethlehem area, connecting it to Ramallah and the western rural areas of Bethlehem Governorate. This road accommodates approximately 20% of the external or through traffic in the study area, according to the counting performed during Phase I. Before it splits into the two directions, given the intense use of the road, there are often traffic

disruptions and delays. Furthermore, the road provisions, such as the newly built roundabout has created confusion and unsafe traffic situations. Furthermore, in most areas of this road, parking is permitted on both sides, reducing significantly its capacity. External bus lines 1, 2, 3, 4, 5, 7 and 8 also use this road to reach their destinations in the west of Bethlehem.

**Photo 9.** Beit Sahur main road



**Bottleneck 11 – Beit Sahur old city centre**

The city centre of Beit Sahur is also facing traffic challenges, especially during rush hour, mainly due to the limited area - the road has a narrow section, a concentration of attractions and amenities (a church, a mosque, a school, shops), but also incorrect and sometimes illegal usage of the road. In some areas, parking is permitted (on marked spots), mostly for residents, but illegal parking is also common.

**Photo 10.** Beit Sahur old city centre



### **Conclusions**

The general remark about the road infrastructure is that there is no coherent categorization, based on capacity, function, speed and location, while the network presents an uneven distribution, with high capacity roads discharging directly in city streets (with a much lower capacity). There is no balance between use, surrounding and design. Moreover, most of the streets are prone to unsafe traffic situations, due to various reasons: infrastructure – poor quality of the pavement, poor quality of marking and signalling; enforcement – there is hardly any supervision or enforcement of traffic law and regulations application; behavioural – people are used to a certain way of using the streets and carrying their everyday life, mostly centred on private car driving. Congestion and delays are almost never structural or systemic, due to too little road capacity, but mostly because of the same reasons mentioned before. On the other hand, Bethlehem area presents many opportunities related to traffic, since it disposes of a dense network; that allows for many options.

### 3.7 Public transport

In general, public transportation in Palestine sector suffers from several difficulties, including an outdated bus fleet, service provision is inefficient, irregular and in some areas, inaccessible. The following section describes and analyses the challenges that this mode presents in terms of organisation, infrastructure and cultural and educational aspects.

#### *Organisational aspects*

The public transport institutional organisation within the study area comprises of different arrangements between bus companies or individual investors that obtain route concessions (licenses) from the Ministry of Transport (MoT). Bus companies and individual investors, who operate the shared taxis (7-seater) and shared cabs (4-seater), transit within and outside Bethlehem.

Traffic Law No. 5 of 2000 from the Ministry of Transport of Palestine, which regulates the requirements for obtaining the respective route license, also regulates the age of the public transport fleet:

- » Shared taxis and shared cabs older than 18 years cannot provide public transport services.
- » Buses older than 20 years cannot provide public transport services.
- » Vehicles older than 10 years (including public vehicles and buses) must renew their licence every 6 months.<sup>37</sup>

Vehicle licenses in Palestine are issued in the form of license plates and do not expire. The costs for acquiring a license for operating as a public transport provider for shared taxis and shared cabs are between 20.000 and 40.000 Jordanian Dinars. The yearly costs of operation are around 800 Shekels. It is important to highlight that licenses can be rented and exchanged to other vehicles. If the license is rented the yearly operation costs are 2.700 Shekels. One of the main requirements for renewing this yearly license for operation consists of a valid vehicle technical inspection, as well as the physical and physiological fit of the driver.

Currently there is not a standard fare structure that considers topics such as vehicle depreciation, transported passengers, travelled kilometres or fuel consumption. Payments are done to the driver of the public transport vehicles. The price of a trip is determined by the type of vehicle and the route; the costs varies from 2 to 50 Shekels and are established by The Ministry of Transport and corrected and adapted "on-site" to local conditions.

The bus owners and the drivers that work for them derive their income directly from passenger fares. Earnings are also invested in the maintenance of the vehicle. Since drivers' monthly payments depend on the number of transported passengers, working hours can last sometimes more than 12 hrs which might reflect on insecure situations due to tiredness of drivers. For example, drivers that transport citizens that travel to Jerusalem for work purposes, begin their routes around 4:30 am.

#### *Public transport infrastructure*

Public transportation in Bethlehem governorate (as many other cities in developing economies) is planned by the service providers. This means that bus companies, shared taxis and shared cabs have each set their "informal" rules for establishing routes, schedules and rules of operation. This has not been controlled by the governmental agencies which hinders a proper public transport planning based on demand.

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<sup>37</sup> Ministry of Transport of Palestine, *Traffic Law No. 5 of 2000, Article 11 and 15*. Available at: <http://www.mot.gov.ps/pallaw52000/>

As mentioned before, there are different types of vehicles providing public transport services in the study area. According to the MoT there are 147 buses, 368 shared taxis and 120 shared cabs in circulation with a license to operate in Bethlehem area (**Photo 11**). As mentioned before, most of the fleet is old; some of vehicles have exceeded their lifespan, especially the large and small buses.

**Photo 11.** Types of vehicles providing public transport services in Bethlehem conurbation – a) Large bus; b) Small bus; c) Shared taxi; d) Shared cab



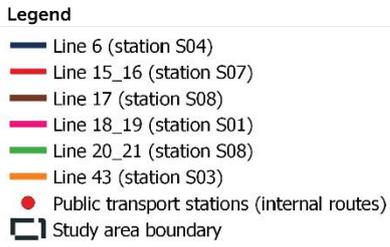
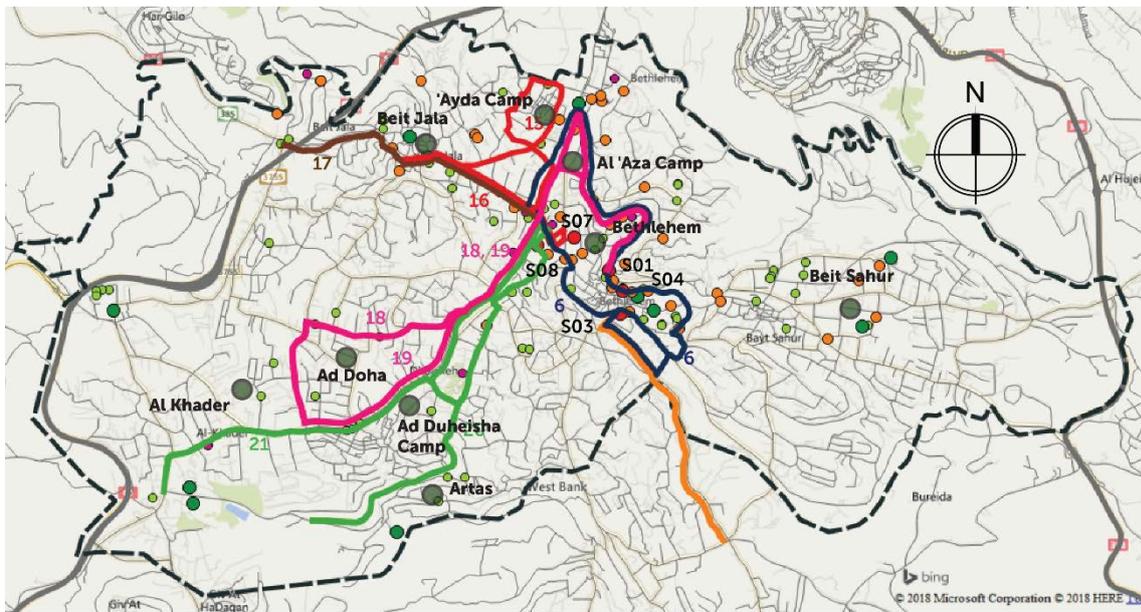
These vehicles are currently serving the 47 (11 internal and 36 external) public transport routes within and to/from the study area. Internal routes, are operated by small buses, shared taxis and shared cabs while large buses are only travelling to areas outside the Governorate. However, not all the areas of the Bethlehem conurbation are served by any of these routes. Furthermore, during rush hours or in areas with bottlenecks, public transport drivers change the course of the route. Although this practice is illegal, the lack of enforcement permits the situation.

Overall, there are nine internal routes or lines, operated from various stations in Bethlehem – line 6, 15, 16, 17, 18, 19, 20, 21 and 43. They serve various areas of Bethlehem, Beit Jala, Ad Doha, Al Khader, Ad Duheisha Camp, Artas, the industrial area and 'Ayda Camp. **Map 12** and **Table 17** present more details regarding routes, origin and destination, leaving station and types of vehicles that operate.

In terms of operation rules, the vehicles do not have a set or fixed schedule, they start their journey once the capacity of the vehicle is full. Currently, there are no designated stops along the public transport routes. A situation is created that allows users to stop the vehicle at any point along the journey either to board or disembark it. This situation positions the public transport into a door – to – door system. Furthermore, the

lack of the stops creates unnecessary bottlenecks in the traffic flow and creates an unsafe traffic situation. By lacking a schedule and fixed, safe and passenger friendly stops, the internal public transport systems become unreliable and inconsistent.

**Map 12.** Internal public transport routes

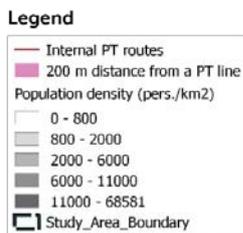
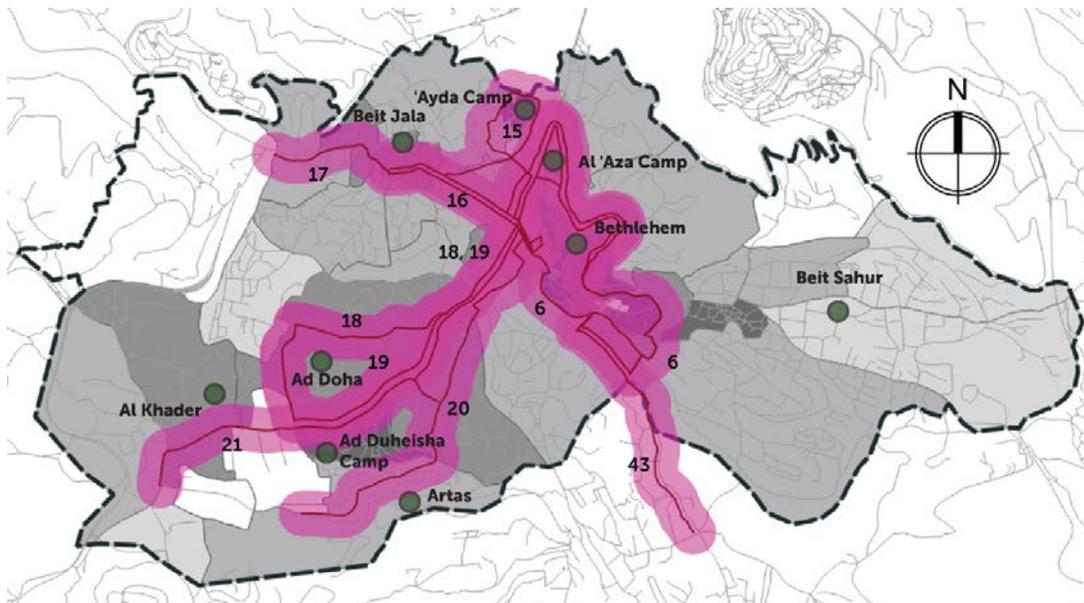


**Table 17.** Internal public transport routes in Bethlehem conurbation

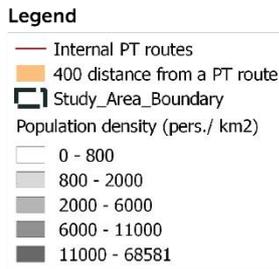
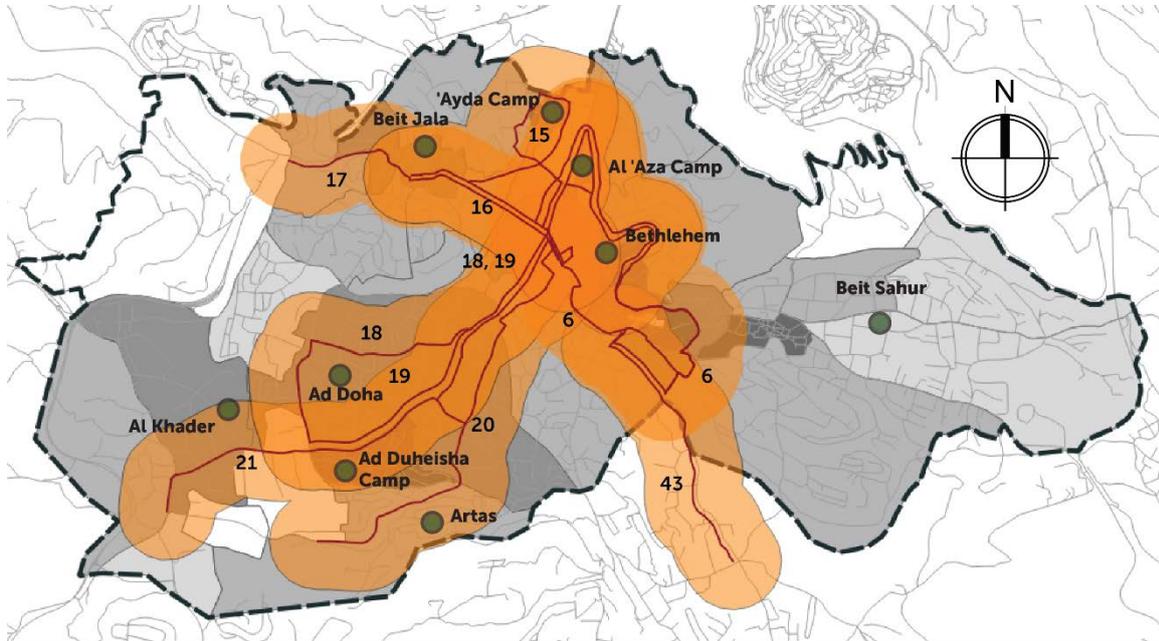
Station	Line #	TYPE	Origin	Destination	Type of vehicle	Remarks
S04_36	6	Internal	Bethlehem	Beit Sahur/ Al Saf Street Bethlehem	Shared Cab / Small Bus	1. One bus on Friday 2. Beit Sahur buses do not work anymore
S07_25	15	Internal	Bethlehem	Aida Camp	Shared Taxi / Small Bus	Friday Off
S07_25	16	Internal	Bethlehem	Beit Jala	Shared Taxi / Small Bus	Friday Off
S08_25	17	Internal	Bethlehem	AL Walaja & Bethlehem Arab Society for Rehabilitation	Small Bus / Shared Taxi	1. Friday Off 2. There are only 2 shared taxi working on this route but not always available.
S01_37	18	Internal	Bethlehem	Ad Doha	Shared Cab / Small Bus	
S01_37	19	Internal	Bethlehem	Ad Dohaisha Camp	Shared Cab / Small Bus	Buses: 7:30 to 15:30 and Friday off
S08_25	20	Internal	Bethlehem	Artas	Shared Taxi	
S08_25	21	Internal	Bethlehem	Al Khader	Shared Taxi	Mostly Friday off but depends on the university students
S03_38	43	Internal	Bethlehem	Industrial Area	Shared Taxi	

As shown in **Map 13** and **Map 14**, the internal public transport routes offer a fair coverage for many areas within Bethlehem conurbation, within a 200 m and a 400 m distance. Nevertheless, there are several high population density areas that are barely or not at all covered by any of the PT lines. That is the case in most parts of Beit Sahur, including the city centre and some touristic heritage sites, such as The Shepherds' Fields, some areas of Al Khader and Artas, but also the southern parts of Bethlehem Municipality. In Beit Jala, line 16 stops on Al Al Sahel Street, next to the city centre and line 17 is served by only two vehicles and it does not operate on Fridays, therefore most of the populous areas in this municipality are poorly served by public transport. These results are slightly contradicting the findings of the surveys performed in the previous phase of this project. People in these areas must walk longer distances to access a public transport route or make use of a car or taxi to reach one of the public transport routes or stations. The low accessibility to the service increases the use of the private vehicles which is not ideal for the mobility in a city. Thus, it is essential to perform a reorganisation of the current public transport system in order to fulfil the current demand in the study area.

**Map 13.** Internal public transport routes coverage – 200 m distance



**Map 14.** Internal public transport routes coverage – 400 m distance

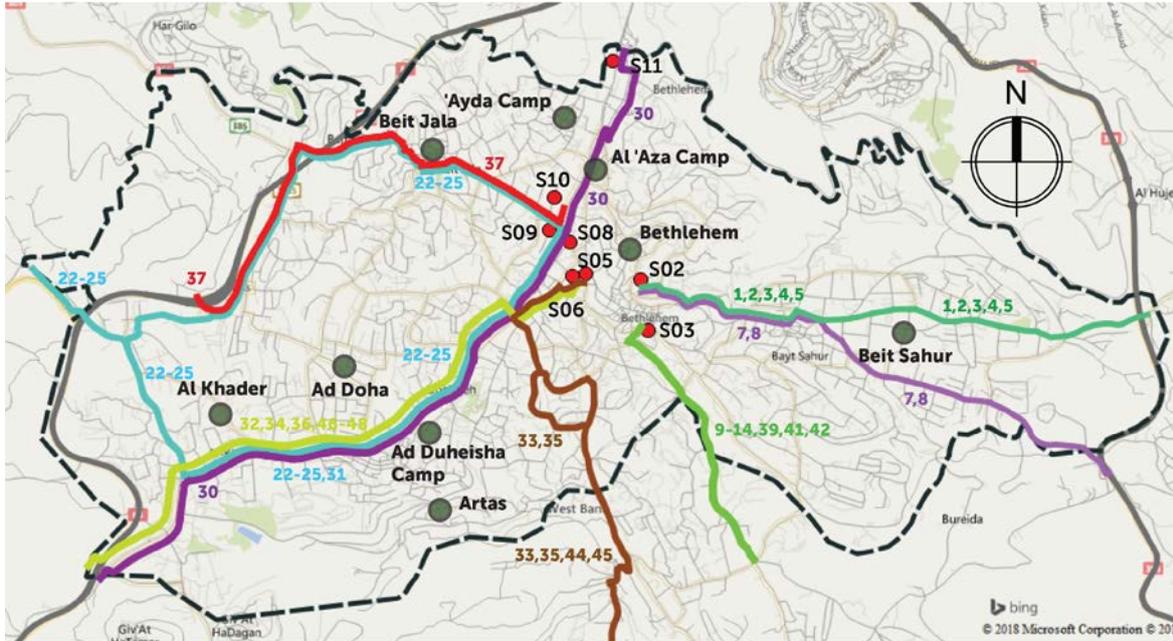


Given its regional position, Bethlehem also serves various external public transport routes, inside and outside of Bethlehem Governorate. Therefore, 36 lines operate in the area, serving rural areas within Bethlehem Governorate and other major Palestinian cities, such as Ramallah and Jericho, outside of the Governorate.

As mentioned in the previous section, the vehicles operating the external public transport routes are using the main arteries of the road network, competing for space with local public transport vehicles, personal cars and taxis. It is important to understand the impact of these routes on the traffic flow in Bethlehem conurbation and to develop a strategy for accommodating all traffic on the best routes. As found in the previous stage of the project, the external PT trips account for about 87% of total PT trips in an average working day, creating approximately 38,700 daily passenger trips, as compared to 5,700 internal passenger trips.<sup>38</sup>

<sup>38</sup> CDG/ ARIJ, (2017), p. 149

**Map 15.** External public transport routes



**Legend**

- Line 1,2,3,4,5 (station S02)
- Line 7,8 (station S02)
- Line 9-14,39,41, 42, 57 (station S03)
- Line 33,35,44,45 (station S05)
- Line 32,34,36,46,47,48 (station S06)
- Line 37 (station S10)
- Line 30 (station S09)
- Line 22,23,24,25,31 (station S08)
- Public transport stations (external routes)
- ▭ Study area boundary

Both internal and external public transport routes are operated starting from main bus stations, which are mostly located in the city centre of Bethlehem, generating disruptions and bottlenecks in the traffic flow. In many cases, stations are located along the road, as it is the case of station S09 and S10 (see **Photo 5** and **Photo 12**). In other cases, the stations have a dedicated area where the vehicles station and wait for customers (**Photo 12**).

**Photo 12.** Bus station S10, at the side of the road; Bus station S02 organised in a dedicated area



**Table 18.** External public transport routes

Station	Line #	TYPE	Origin	Destination	Type of vehicle	Remarks
S02_37	1	External other Governorates	Bethlehem	Ramallah	Shared Taxi	
S02_37	2	External other Governorates	Bethlehem	Jericho	Shared Taxi	
S02_37	3	External other Governorates	Bethlehem	Abu Dis	Shared Taxi / Small Bus	
S02_37	4	External Beth. Governorate	Bethlehem	Al Obiediya	Shared Taxi / Small Bus	
S02_37	5	External Beth. Governorate	Bethlehem	Dar Salah	Shared Taxi / Small Bus	
S02_37	7	External Beth. Governorate	Bethlehem	Esh Shawawra	Shared Taxi	
S02_37	8	External Beth. Governorate	Bethlehem	Za'atara	Shared Taxi	
S03_38	9	External Beth. Governorate	Bethlehem	Tequ	Shared Taxi	
S03_38	10	External Beth. Governorate	Bethlehem	Beit Ta'mar	Shared Taxi	
S03_38	11	External Beth. Governorate	Bethlehem	A'Asakra	Shared Taxi	
S03_38	12	External Beth. Governorate	Bethlehem	Janata	Shared Taxi	
S03_38	13	External Beth. Governorate	Bethlehem	Harmalah	Shared Taxi	
S03_38	14	External Beth. Governorate	Bethlehem	Nos AL Oqban ( Al Firdas)	Shared Taxi	
S08_25	22	External Beth. Governorate	Bethlehem	Battir	Shared Taxi	If the taxi drive through Jerusalem - Hebron Road it takes 60 minutes
S08_25	23	External Beth. Governorate	Bethlehem	Husan	Shared Taxi / Small Bus	
S08_25	24	External Beth. Governorate	Bethlehem	Nahaleen	Shared Taxi	
S08_25	25	External Beth. Governorate	Bethlehem	Wadi Fuqin	Shared Taxi	1. Friday usually Off 2. It takes 20 minutes if the shared taxi goes through Beit Jala and 1 hour through Jerusalem - Hebron Road
S09_21	30	External other Governorates	Bethlehem	Hebron	Shared Taxi / Small Bus / Large Bus	during congestion it takes 90 minutes
S11_15	30	External other Governorates	Bethlehem	Hebron	Shared Taxi / Small Bus / Large Bus	during congestion it takes 90 minutes
S08_25	31	External Beth. Governorate	Bethlehem	Beit Fajjar	Shared Taxi / Small Bus	Friday Off
S06_25	32	External Beth. Governorate	Bethlehem	Wadi en Nis	Shared Taxi	Friday Off
S05_25	33	External Beth. Governorate	Bethlehem	Wadi Rahal	Shared Taxi	Friday Off
S06_25	34	External Beth. Governorate	Bethlehem	Jourt esh Sham'a	Shared Taxi	Friday Off
S05_25	35	External Beth. Governorate	Bethlehem	Abu Njaim	Shared Taxi	Friday Off
S06_25	36	External Beth. Governorate	Bethlehem	Umm Salamona	Shared Taxi	Friday Off
S10_22	37	External other Governorates	Bethlehem	Jerusalem Buses	Large Buses	
S03_38	39	External Beth. Governorate	Bethlehem	Brita'a	Shared Taxi	
S03_38	41	External Beth. Governorate	Bethlehem	Al A'roj	Shared Taxi	
S03_38	42	External Beth. Governorate	Bethlehem	Rakhmeh	Shared Taxi	
S05_25	44	External Beth. Governorate	Bethlehem	Marah Rabah	Shared Taxi	Friday Off
S05_25	45	External Beth. Governorate	Bethlehem	Khalayel Al Looz	Shared Taxi	Friday Off
S06_25	46	External Beth. Governorate	Bethlehem	Marah Me'alah	Shared Taxi	Friday Off
S06_25	47	External Beth. Governorate	Bethlehem	Al Ma'asara	Shared Taxi	Friday Off
S06_25	48	External Beth. Governorate	Bethlehem	Khelat Al Hadad	Shared Taxi	Friday Off
S08_25	49	External Beth. Governorate	Bethlehem	Al Arkoub	Shared taxi	Friday Off
S03_38	57	External Beth. Governorate	Bethlehem	Hindaza	Shared Taxi	

### Cultural aspects

In general, the public transport users believe that the PT system is good but it has potential to improve. For example, the performed surveys from Phase 1 show that there is a lack of public transport early in the mornings and late in the evenings. Furthermore, several car users prefer this mode over the public transport system due to the accessibility to any route and the lack of schedule. This target group prefers not to use the shared taxis or cabs because of the waiting times in the stations until the vehicle has completed its capacity.

This is more time consuming than doing the same trip by car, especially if the trip is to another governorate. One additional factor that hinders the use of public transport is the fuel cost in the region. Currently, one litre of diesel cost 5.92 Shekels, Gasoline 95 and 98, 6.36 and 7.10 per litre respectively. These prices are similar to the cost of round-trip journey on public transport. However, travelling by car results to be more efficient since with one litre of fuel, a person can perform more than one trip. Consequently, driving a private vehicle is more attractive for car owners since it is more cost-effective in terms of price, comfort and travel time.

Nevertheless, surveyed people do believe that a more organised system, with coherent routes, stops and schedules could be of great advantage for better mobility, accessibility and liveability in the area. However, changes to the current system and organisation might be complicated and could face opposition from the current transport operators. Since the individual vehicle owners usually make their profits from the current system, reorganisation or readjustments are terms that they tend to instinctively oppose. Winning over the current transport sector, while achieving public support from both customers and PT operators, is perhaps one of the biggest challenges towards the successful implementation of any measure related to public transport for the Bethlehem conurbation.

**Main dysfunctionalities**

**Photo 13.** Public transport dysfunctionalities – a) PT vehicles are caught in traffic congestion; b) Bus is parked/ stationed illegally; c) Unsafe boarding and un-boarding; d) Poor quality of the public space



There are several aspects that have an impact on the efficiency of the public transport system. Most of them have been highlighted in the previous sections of this chapter. These impediments lead to an increase in travel time in public transport, have a negative effect on mode choice and increase operating costs. Particular challenges are:

- » Travel-time loss due to waiting times in the stations.
- » Reduced speeds on routes caused by insufficient space due to poor road design (e.g. the Nissan roundabout which is too tight to permit larger vehicles to turn safely), parked cars on the side of the road, poor road surface conditions, basically inexistent road signalling and marking specific for PT.
- » Reduced speeds on routes due to PT vehicles being caught in traffic congestion.
- » Unreliability and volatility due to the lack of schedule and stops.
- » Unsafety of boarding and un-boarding PT vehicles, due to the lack proper organised and designed stops along the routes.
- » Insufficient coverage within reasonable walking distance for many people in various municipalities within the study area.
- » Some of the PT stations and vehicles contribute to reducing the quality of the urban space - stations that are semi-informal, at the side of the road, stationed vehicles on illegal spots, anti-social behaviour and so on.

### **Conclusions**

Improving PT conditions and coverage can lead to a higher demand and use, creating more potential for development – a virtuous circle. Public transport has a high share of use in Bethlehem area, for both internal and external trips and this is a factor that needs preserved and built upon. The PT system needs to become more attractive and efficient and for this it needs a reorganisation.

### 3.8 Non-motorised transport

#### *General considerations*

Non-motorized urban transport (NMT) is an essential element of clean urban transport. NMT supports the sustainable development of a transportation system and it includes two main modes - walking and cycling. These modes can be desirable for relatively short distances, which, in general, make up for the highest number of trips in cities. Increasing the modal share of NMT is possible in any urban and non-urban area by considering some factors such as climate, geography, culture, and attractiveness. In addition, by promoting walking and cycling in the city, liveability can be increased, since these modes provide healthy exercise and enjoyment. Walking is a fundamental activity for physical and mental health. In general, NMT can improve the quality of life. More precisely the benefits of NMT are:

- » **Environmental:** increasing air quality and reducing GHG emissions.
- » **Social:** walking does not cost money and can reduce poverty and bring social equality, providing equal opportunities for people of all age, religion, gender, etc.
- » **Health:** NMT improves physical activity of citizens and public health. There is a strong connection between physical activity and reduced risk of overweight and obesity. Obesity can cause serious diseases like diabetes and high blood pressure. These diseases not only bring suffering for one but also have high costs for society. Besides that, walking can influence the mental health of individuals, increasing happiness levels.
- » **Economic:** NMT makes the city more attractive for tourists especially by providing car-free zones and reducing travel time because of traffic fluency. Besides that, increasing the pedestrian traffic in a commercial area can attract more customers and increase the sales volumes,
- » **Safety:** NMT has a direct effect on reducing the number of accidents by providing safety for all citizens including vulnerable group such as disabled people, old people, and children. NMT oriented planning reduces the speeds of cars in neighbourhoods making them more liveable and safe for all road users.

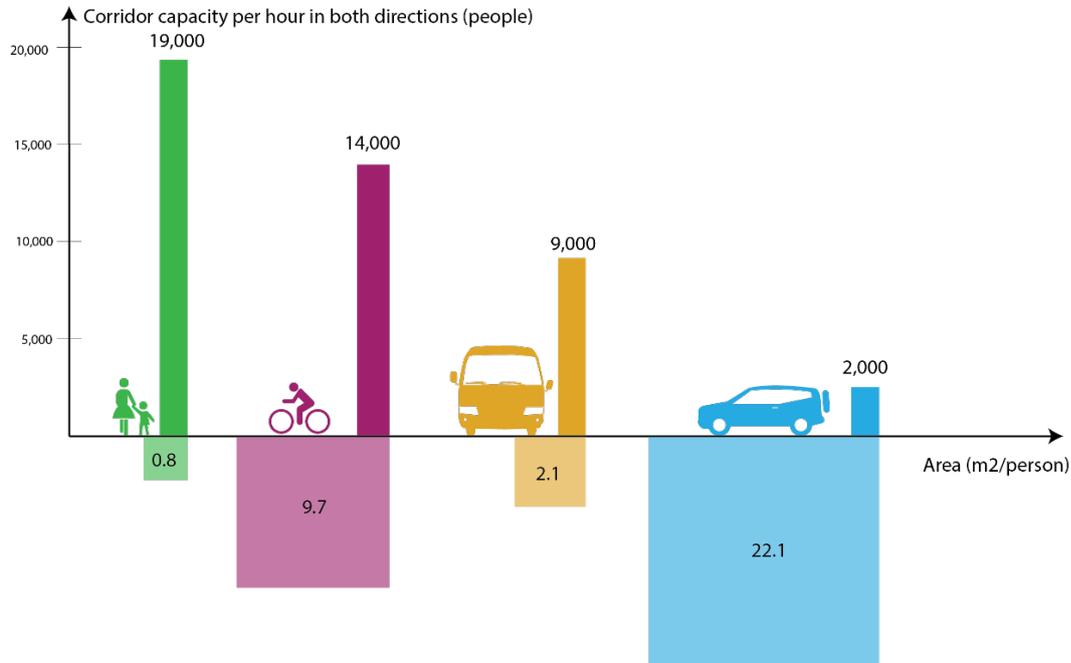
Walking is the only mode available as non-motorised transport mode in Bethlehem conurbation. In general, in the study area, only 9% of the trips are made by walking. The highest number of walking share belongs to students. The results of the survey performed during the previous phase of the project – Data Collection show that nearly 50% of pupils walk to school. That is mostly the case of pupils that attend public schools.

#### *Pedestrian facilities quality*

The pedestrian network infrastructure refers to street furniture, lights, quality and size of pavement, consideration for vulnerable groups. Overall, the quality of the pedestrian infrastructure in Bethlehem conurbation is low. There are no streets or squares where access to vehicle is restricted or forbidden, therefore we cannot discuss about exclusively pedestrian facilities in the study area.

Like in most of the urban areas around the world, also in Bethlehem, walking has been overlooked as a means of transportation and has been underrepresented in terms of planning and investments. This is reflected in the low number of trips performed by walking and in the declining number of pedestrians. The result of the competition among different uses for space has been that the “leftover” space has been assigned to pedestrians. But space is important in Bethlehem area, since land is scarce and growth is limited by numerous factors, including the Israeli occupation and control. Walking is the most space-efficient transport mode, which needs the least expensive and complex investments, as well. In comparison, while car infrastructure has a capacity of around 1,800 people per hour per lane on motorways, with 22.1 m<sup>2</sup> per person needed and a capacity of only 900 people on city streets, walking infrastructure can accommodate 17,000 people per hour with as little as 0.8 m<sup>2</sup> per person (*Figure 11*).

Figure 11. Capacity and space demand per transport mode

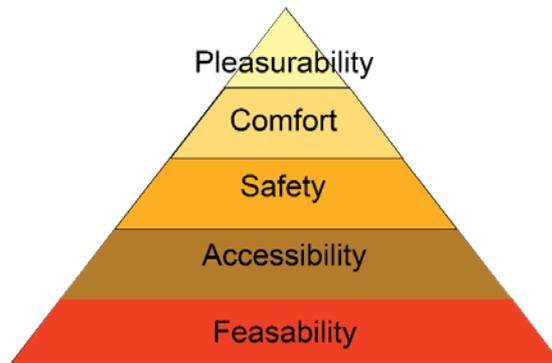


Note: Space demand per transport mode includes both space required for movement, streets and carriageways, and for parking

Source: TÖI, Norwegian Centre for Transport Research, SUMP Malmö and UITP

Studies have determined there are certain conditions and needs that must be fulfilled to increase the share of walking in a city. These are mostly related to: feasibility (age, physical mobility, etc.) accessibility (existence of pavements, distance, proximity of amenities within walking distance, quantity and the quality of nearby amenities and infrastructure etc.), safety (traffic safety, crime levels, litter, illegal activities), comfort (street trees, sidewalk buffers) and pleasurability (aesthetic appeal).

Figure 12. Hierarchy of walking needs



Source: Alfonzo, 2005<sup>39</sup>

<sup>39</sup> Mariela Alfonzo, "To Walk or Not to Walk? The Hierarchy of Walking Needs", *Environment and Behaviour*, vol. 37, issue 6 (2005) p. 808 - 836

The basic underlying element is feasibility, which does not relate to urban space or built environment per se, but refers more to the possibility to walk from the people’s point of view – age, gender, health level, physical mobility, etc. Given the fact that approximately 70% of the population is below 29 years of age, walking is a transport mode that could have a high rate of uptake, if other conditions would be met. There is no data on disability at city level, but numbers at national level show that disability is most prevalent at older aged people, with approximately 3 - 4% of people younger than 34 suffering from a disability. Nevertheless, mobility related disability is the most common, with about 49% of the cases.<sup>40</sup> In general, there is no consideration given to vulnerable groups and at the same time there are no provisions for people with reduced mobility or impaired vision (lowered pavement, acoustic signals, etc.).

Accessibility refers to both infrastructure indicators and land use ones, for example: proximity of attractions and amenities, existence of pavements. Overall, the pedestrian networks are not well connected, because walking is not well defined as a mode of transport in this city. Priority is given to motorised transport and especially towards the private car transport. In the city centre of Bethlehem, there are some areas which are entirely paved for pedestrians (such as the Star Street), but cars still have access to these areas. Overall, there are no streets and zones that are exclusively pedestrian area. Furthermore, in the city centre and the commercial part of the city, shops block pedestrian’s paths with their goods and stands. In addition, many pedestrian paths are blocked by waste from buildings constructions or parked cars (*Photo 14* and *Photo 15*).

Most of the pedestrian paths have been paved well, but in some areas, pavement is missing, is not continuous or properly marked and separated from other transport modes (*Photo 16*). However, in the proximity of some schools there are some separated pavements, as it is the case on Manger Street. On the other hand, to be truly walkable, besides infrastructure, cities must have destinations to which people would want to walk. This is the strongest point of Bethlehem, since commercial areas, restaurants and hotels are concentrated areas, providing attraction zones.

**Photo 14.** Pavement blocked by shops goods and by construction sites materials



<sup>40</sup> PCBS and Ministry of Social Affairs, *Disability Survey*, (Ramallah: Palestine, 2011)

**Photo 15.** Pavement is blocked and occupied by parked cars



**Photo 16.** Pavement is missing (area in Bethlehem), pavement is renewed and in good state (area in Artas)



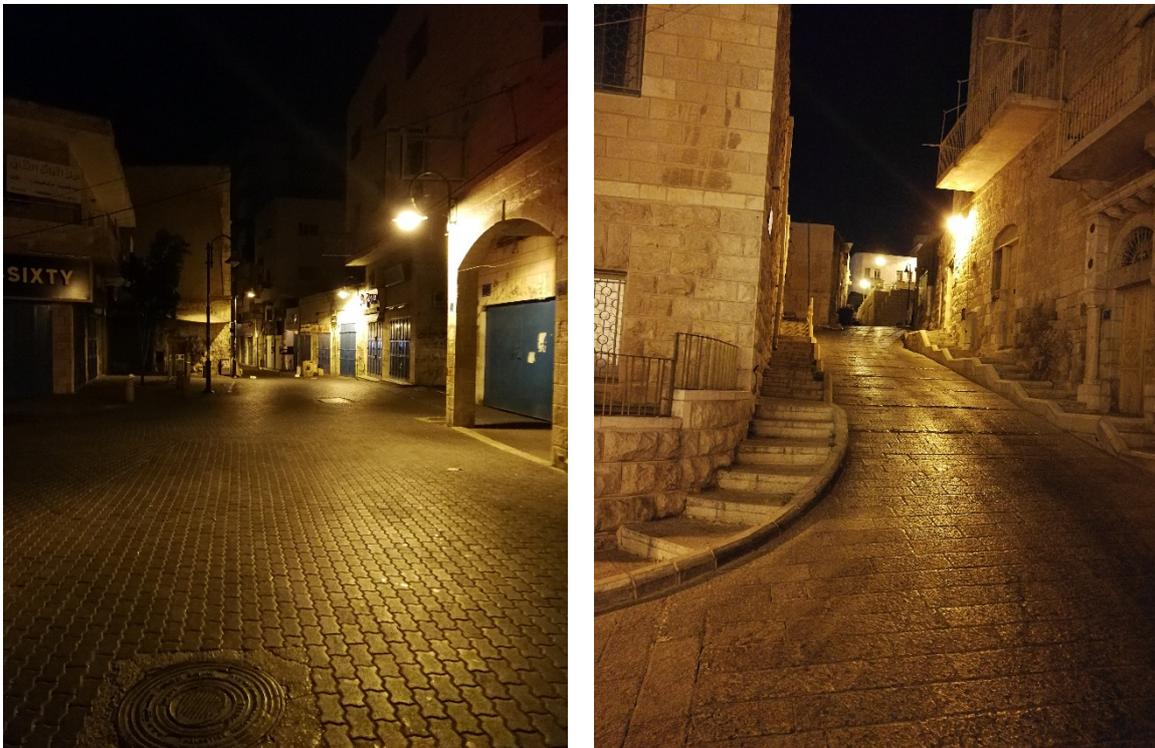
On the most fundamental level, people must be and feel safe, for an area to be considered truly walkable. Some 30 km zones are available in the city which makes walking safe, but because the pedestrian paths are not well separated from the streets, they are accessible by cars and become parking spots. Overall, there are no car-free areas in Bethlehem conurbation. Almost everywhere there is a conflict between pedestrians and motorised transport, especially at crossings and on narrow streets, where there is mixed traffic. All these make walking possible, but dangerous and inconvenient. Conflicts occur mainly through the competition among the various demands for limited available space. Particularly the demand for space for car parking puts limitation on walking. For example, cars can easily park on pavements and people must use the road and walk between the cars. For crossing the streets, there are some traffic signs, but marking is inexistent or barely visible.

**Photo 17.** Conflicts between pedestrians and motorised vehicles, unsafe crossings



On the other hand, during night, streets are foreseen with enough lights to encourage walking and social activities, but since walking is not popular and people are not used to participate at street and urban life as pedestrians, in general, after dark sets in, streets are mostly empty. This is, of course, connected also to the lack of exclusively pedestrian areas.

**Photo 18.** Well-lit streets at night in Bethlehem and Beit Jala



Comfort and pleasurability refer mostly to the quality of the pedestrian network and of the urban space in general. Urban spaces are meant to belong to people, not to vehicles. Urban designers and planners advocate for “pedestrian stays”: places where people are invited to stay, sit, linger in order to participate at

the public life and consolidate the community. A high quality of urban space can significantly increase the number of pedestrians and their stay in the public area. Unfortunately, Bethlehem does not have many areas or streets designed for people. The fundamental key to make people walk is make the walking paths interesting by adding cultural amenities such as public art, water features, trees, public events and sidewalk cafes. These are partially present in the area, with big concentrations of historical heritage sites, hotels, restaurants and commercial amenities. But information about routes to this sites and locations are scarce, there are hardly any boards signalling their presence or giving attractive information about that. The creation of such “routes” guiding the people from one important or attractive location to the other would create more interest in walking.

On the other hand, street furniture is scarce and in poor condition, there are no attractive facilities that would encourage people not just to walk to their destination, but also to station, take rest and participate in street and urban life. Moreover, on pavements along the streets there are almost no greenery or landscape provisions. Therefore, in terms of pleurability, it can be concluded that the current state of pedestrian facilities does not encourage walking as either a transportation mean or a leisure activity.

**Photo 19.** Public space with a potential to become pedestrian that is now occupied by cars



**Conclusions**

In the 21st century mobility and urban planning views, walkability is considered a key element of an efficient and sustainable urban transport system. Providing good facilities for pedestrians and increasing the quality of urban space will in turn provide for a better quality of life for people, a stronger community and a more vivid and healthy urban life. Walking provides for an inclusive and equal mobility for a large number of users (especially for the vulnerable ones), providing easy access to facilities, amenities, jobs, leisure activities and education.

Bethlehem area should become a walkable area, focused on providing enough and balanced space for pedestrians, recognising that roads are both social spaces and space for mobility. Safety of path and crossings, together with a pleasant environment supported by good design streets could increase significantly the use of walking as both a transport means, and a social activity. The study area has a great potential to become walkable and sustainable and this potential needs to be tapped into thorough planning and strategies oriented to people.

### 3.9 Parking

#### *Regulatory system and effectiveness*

On-street and off-street parking regulation in Palestine is established by the MoT and executed by each municipality. Off-street parking is mainly done at privately own lots and buildings (*Photo 20*) which operate on a yearly land license. Prices are set by the owner and offer daily parking fees with an estimated average cost of 7 NIS/day in the centre of the city and 10 NIS/day near the entry-exit point Jerusalem, Checkpoint 300.<sup>41</sup>

*Photo 20. Off-street parking – a) paid parking lot; b) paid parking inside building*



On-street or road-side parking is only permitted on roads where the curb stone marking is either black and white (free parking) or blue and white (charged parking) (*Photo 21*). It is important to highlight that paid parking is only available on Manger and Paulus VII (Bethlehem City) streets. The road side paid parking is set or owned by the municipality. The municipality announces every five years a call for participation for a tender for private companies. The Municipality receives yearly a fixed amount of money per parking sport. Since 2014 a company called Techpark is running the road side paid parking in Bethlehem for 850 shekels per spot per year.

<sup>41</sup> CDG/ ARIJ, (2017), p. 49

**Photo 21.** Road side parking – a) black/white curb stone; b) paid blue zones



Although parking is prohibited on red and white painted curbs and fines for using this space are high (approximately 150 Shekels), car users often use these areas to park their vehicles due to the reduced enforcement by police (**Photo 22**). This situation is persistent especially in areas where there are scarce parking spaces.

**Photo 22.** Road side parking a) Red and white forbidden parking areas; b) Illegal parking



This lack of control together with the lack of a suitable parking study has resulted in public spaces, such as sidewalks packed with cars generating substantial barriers for walking and reduced road safety. In some cases, car owners prefer to park on the sidewalks even when parking is permitted on the street due to fear of their vehicles being damaged (**Photo 23**).

**Photo 23.** Parking on sidewalks



Additionally, in areas where parking is allowed on both sides of the street, bottlenecks can be seen in rush hour specially on narrower roads. This situation affects the mobility in different areas of the Bethlehem conurbation (**Photo 24**).

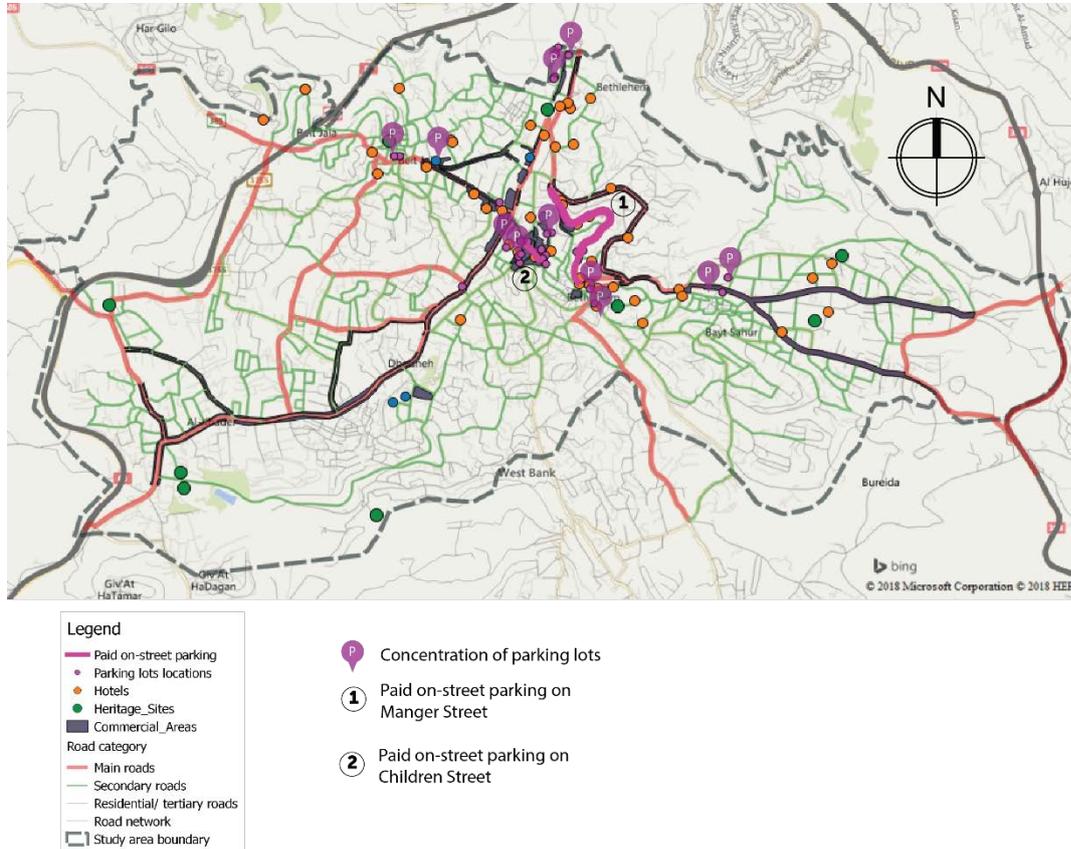
**Photo 24.** Parked cars causing bottlenecks



**Parking infrastructure and demand**

Phase I of this project determined that in Bethlehem conurbation there are 5,663 parking spaces, of which 2,825 are public and 2,838 spaces are private (residential and paid parking lots). Road side paid parking on Manger and Paulus VII has a capacity of approximately 192 spaces. The parking capacity of the paid parking lots is about 1,790 spaces. On the **Map 16**, the location of the parking lots and paid areas can be identified. Most of them are in Bethlehem city surrounding main attraction centres such as churches, commercial areas and civil and public administration offices.

**Map 16. Parking locations in Bethlehem conurbation**



There is not a designated parking area for tourist buses outside the city centre. Most of them embark and disembark tourists in front of hotels resulting in traffic delays and congestion. This is seen especially in Bethlehem city centre, on Manger Square and Karkafeh Street due to its proximity to the Nativity Church, one of the main tourist attractions of the city. Additionally, there is an increasing demand for parking spaces for visitors from East Jerusalem and Arab communities in Israel which often arrive to the study area by car. If these visitors commit a traffic infraction, the Palestinian police cannot impose any fines for violations of traffic law.

**Main dysfunctionalities**

Although Bethlehem conurbation has a clear regulation concerning on- and off-street parking, there is not a concrete and well enforced parking strategy that tackles car usage. This has led to the following situations:

- » Road bottlenecks due to parking on both sides of the road on streets of reduced width.
- » Reduced space for pedestrians because of car parking on sidewalks generating unsafe situations for citizens and visitors.
- » Parallel and perpendicular parking on side roads, creating conflicts with incoming traffic due to space reduction.
- » Increase access to car traffic and touristic buses to cultural and heritage centres, increasing congestion in the area.
- » Increasing demand for parking spaces due to the low parking fees.

### **Conclusions**

Establishing and enforcing on- and off-street differentiated paid parking policy is essential for Bethlehem conurbation, especially in areas of high trip attraction. Its implementation can improve the current mobility situation by freeing up space for moving vehicles, reducing travel of motorists searching for spaces, and encouraging the greater use of public transport in congested areas with limited parking spaces.

### 3.10 Road safety

#### *Policy and regulations*

Over the past 18 year the Palestinian Council of Ministers has been working on modifying items in the Traffic Law No.5 from 2000, which has been since then the basis for the laws used for regulating traffic and transportation in Palestine. In 2005, 2008 and 2009 the Council of Ministers made changes and updates in the Traffic law, and together with the main law adopted, they form the traffic law used in Palestine today.

The Palestinian Traffic Law No.5 regulates licensing of vehicles, condition of the vehicles, driver's license, traffic rules and ethics, public transport vehicles, speeds, road accidents, and other topics related to traffic. It is very comprehensive and covers all related traffic issues, and over the years has been modified to suit the changes in the environment and society.

#### *Road Safety Manual*

The main reference for road and safety technical specifications can be found in the Road Safety Manual that was issued in 2013. This manual covers the technical specifications and safety precautions of road design, vehicles, movement, traffic control, road maintenance, parking management, and many other related aspects. It is a comprehensive document that gives answers about all technical parameters needed to the road safety and traffic design.

The following main topics have been described in the manual: vehicles technical and operational parameters; road parameters; traffic control; environment factors; road planning, design, building, operation and maintenance; intersections planning, design, building, operation and maintenance; parking planning, design, building, operation and maintenance; safety precautions (sidewalks, guards, design modifications for disabled people, school safety precautions, awareness, and monitoring).

This manual can serve as the entrance to the design and rehabilitation of roads.

#### *Infrastructure*

All municipalities and village councils continually work on enhancing the quality of the main and vital parts of the road network. Nevertheless, some roads also suffer from poor quality of the road surfaces. Examples of such roads have been presented in section 3.6. Unsafe traffic situations are created by dangerous works, with poor signalling on the roads, works related to households along the road (e.g. connections to sewage), faulty repair works, executed with poor materials or creating uneven surfaces.

**Photo 25.** Unsafe traffic situations due to: road works, household works, faulty repairs





The street markings and signalling are important when it comes to road safety. For a safe road network a good road marking for the streets is essential. As mentioned above, in section 3.6, most of the roads in Bethlehem conurbation are lacking proper marking and signalling, separating directions and lanes, which encourages chaotic driving, creates confusion and permits dangerous turns or overtakes.

In what sidewalks are concerned and the safety of pedestrians, the main challenges and dysfunctions have been discussed in detail in section 3.8. Also in this field, the situation is not much better than the one of roads. In many cases, pavements are used for parking cars, they are in bad condition or are covered with debris. Moreover, in some areas, pavements are completely lacking. All this obliges pedestrians to use the roads, creating dangerous conflicts with driving vehicles.

### Road Accidents

During the year 2017 about 832 road accidents was recorded in the Bethlehem, 7 of which were fatal. **Table 19** shows the distribution of types for the accidents recorded.

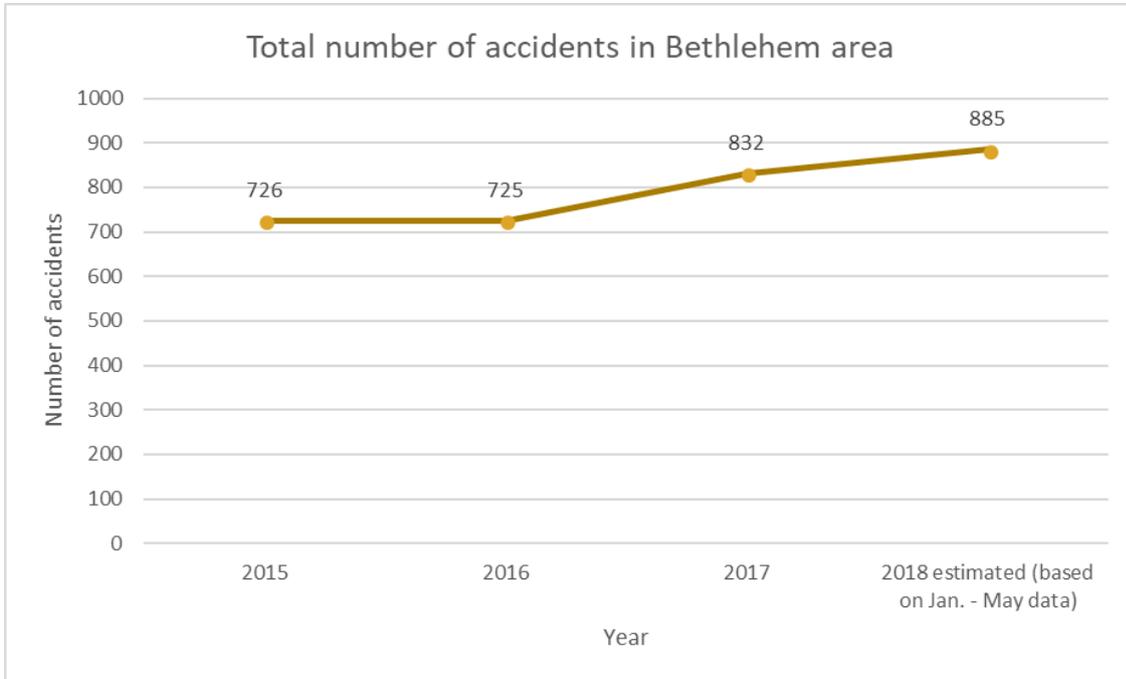
**Table 19.** Traffic accidents in 2017 in Bethlehem area

Type of accident	Number
<b>Accidents with death</b>	7
<b>Accidents with physical injuries</b>	265
<b>Accidents with material damage</b>	414
<b>General accidents</b>	11
<b>Accidents with pedestrians</b>	130
<b>Accidents with animals</b>	5
<b>Total</b>	<b>832</b>

Source: Traffic Police

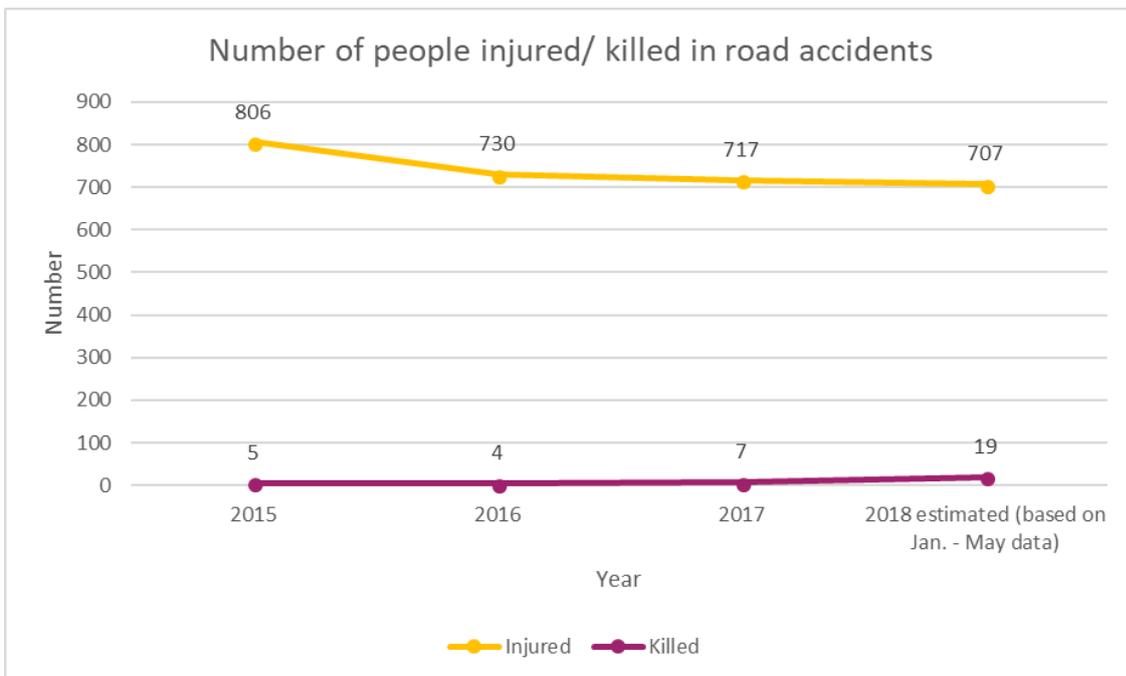
Overall, the total number of accidents increased by about 14% in 2017 compared to the previous years. The Number of death accidents, physical injuries accidents, accidents with pedestrians and accidents with animals did not change noticeably, however, the number of accidents of material damages increased by approximately 31% in 2017.

**Figure 13.** Number of traffic accidents in Bethlehem area in the period 2015 – 2018 (estimation)



Source: Traffic Police

**Figure 14.** Number of people injured/ killed in traffic accidents in Bethlehem area in the period 2015 – 2018 (estimation)

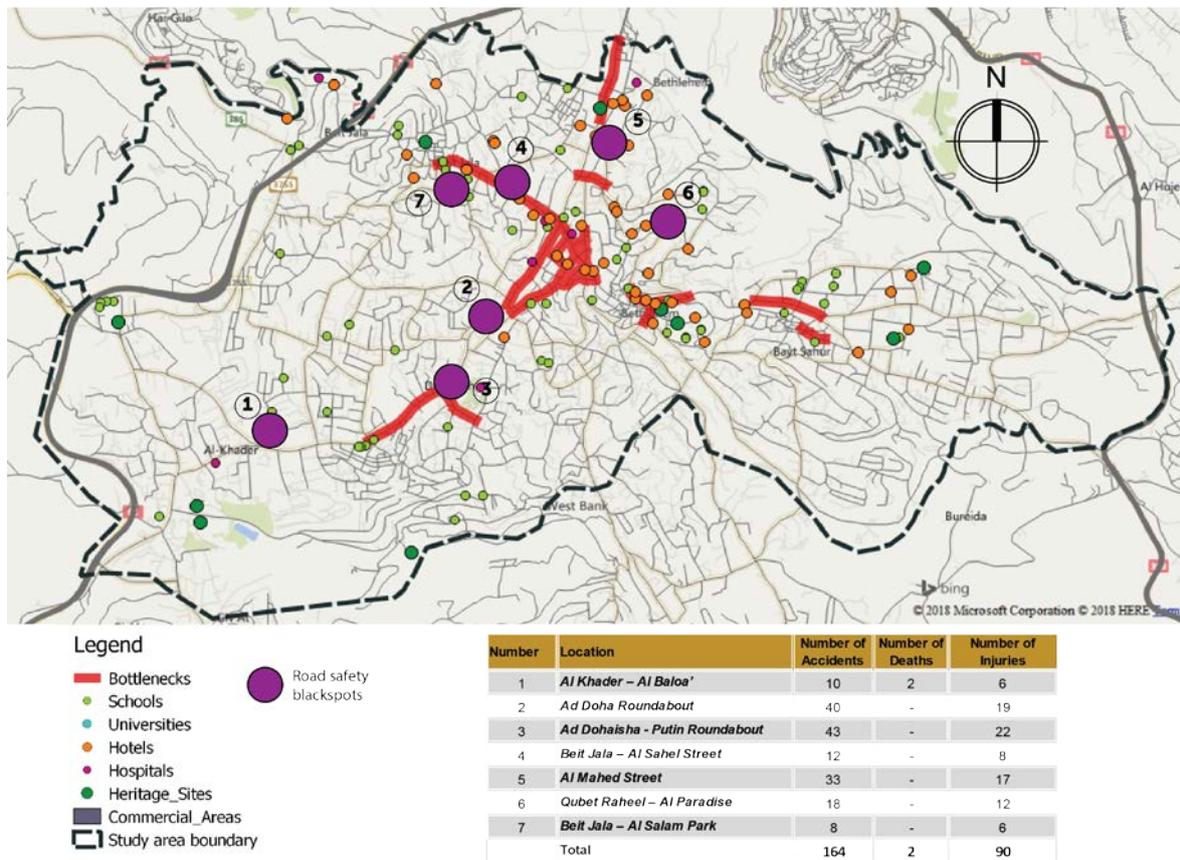


Source: Traffic Police

As for injuries, from the total number of 717 injuries, 89.5% were recorded as minor injuries for the year 2017, whereas 9% and 1.5% of the injuries were recorded as moderate and serious injuries respectively. Although the number of injured people has showed a decreasing trend, the number of death resulting from road accidents has increased compared to 2015 and 2016 and the trend has been consistent in 2018 as well. In 2017 there were 7 deaths recorded throughout the whole year, while in 2018, for the period January – middle of May, there were already recorded the same amount of deaths.

Approximately 20% (164 accidents) of the total number of road accidents that occurred during 2017 were distributed on 7 locations across the Study Area, the so-called black spots of the area.

**Map 17.** Black spots locations in Bethlehem area



Source: Traffic Police

From the records of the traffic police for 2017 about 18,915 tickets were given to traffic participants. An increase of about 18% compared to year 2016 during which about 15,453 traffic violation tickets were given. Furthermore, about 588 vehicles were examined and found illegal which compose approximately about 2.3% of the total 26,371 examined vehicles. Records show that 520 vehicles were detained, 364 vehicles were trashed, 68 motorcycles were confiscated, and 58 motorcycles were trashed.

As shown above, overall, the first quarter of 2018 has shown an increase in the number of accidents and casualties. The number of total accidents reached approximately 40% of the total number of accidents in 2017. From which the number of death accidents has already reached 7 which is the total number of death accidents in 2017. The number of trashed vehicles reached until the middle of May more the 250% of the number recorded in 2017. The number of motorcycles trashed also reached about 60% of the total number

estimated in 2017. All these figures are a reason for concerned and they show that intervention and improvements are needed immediately, in order to stop this progressively increasing trend.

### **Dysfunctionalities**

To enhance the current road safety traffic, the main problems must be identified, dealt with and solved. The main dysfunctions related to traffic safety are:

- » The lack of sufficient police officers and the lack of traffic rules enforcement. The study area suffers from a lack of availability of sufficient traffic police officers. During rush hours the current number is insufficient to cover the whole study area, which leads to more road violations and accidents.
- » Illegal parking, blocking pavements and roads.
- » The illegal vehicles driving around the road network causing many road safety problems. As they are not licenced or insured, they are most probably a danger for people either driving or walking especially because a large share of them do not follow the road safety regulations or policies. The traffic police have been active in that area and in the first 4 months of 2018 about 221 vehicle were removed from the street.
- » Poor behaviour of the drivers. This is an important subject to be highlighted under the section of road safety. Especially related to public transport drivers, as they many times drive with higher speed than permitted, stop anywhere on their route to drop off or pick up passengers and they drive recklessly;
- » Schools are mainly located on main roads and dropping off and picking up students not only creates traffic congestion but is also dangerous for children crossing the road and walking between cars, as there is no special space designed for these actions.
- » A new law has been approved for detaining cars violating regulations and rules, but this law has not been implemented because of the land availability. If the police do not have a safe and appropriate space to detain the vehicles this law can't be put into action.
- » It's worth mentioning that the Palestinian traffic police have no authority over cars coming from Israel. Many times, these drivers create traffic problems, as when they violate regulations and laws they can't be stopped or given traffic violation ticket.

### **Conclusions**

As numbers and situation on the filed show, the road safety in Bethlehem is a major issue that needs to be addressed. In order to achieve a sustainable, inclusive and efficient transport system in Bethlehem area, increasing the safety of traffic participants needs to become a priority (some so-called 0 casualties vision). This will be further elaborated on and taken into account in the strategy development phase.

### 3.11 Mobility patterns and accessibility in Bethlehem conurbation

Understanding mobility patterns and trends is an important step in the analysis of the status of the transport system in the study area. This gives an insight into the way people move, the main challenges that the municipalities and the people are facing in terms of mobility and transport. It provides questions that should be answered during subsequent stages, when the vision, strategy and scenarios are developed. Unfortunately, there is no historical data regarding traffic numbers and patters, so no proper trend analysis can be performed.

This section presents key findings related to mobility patterns, obtained from the analysis of the household surveys performed during Phase I: Data Collection and/or derived from the transport model outputs and from the processing of the data with the MOVE Meter, as presented in our technical offer. Some of the indicators and results refer to locality (municipality) level, other to the whole study area, while other present more refined findings, based on the zoning used for the modelling process.

#### General information about the modelling tools

The processing of the raw data collected in previous stages has been performed in first instance with OmniTRANS 8.0. OmniTRANS is a genuine multimodal and multitemporal system, which is extremely suitable for modelling the interactions between the various means of transport within an urban context. It supports both aggregated and disaggregated methods for modelling the mobility demand.

The public transportation allocation algorithm, based on travel method modalities, is versatile and extensive, thus enabling realistic modelling of complex systems like park-and-ride, kiss-and-ride and bike-and-ride. OmniTRANS is equipped with a detailed and fundamental algorithm for modelling all types of intersection, and offers rich interfaces to define the geometric lay-out, the signal plans and the various configuration periods of intersections. OmniTRANS offers a wide range of formats for the exchange of data, and mechanisms for exchanging with other systems.

The following modelling techniques have been used:

<b>Modelling technique</b>	Trip generation	For each period (morning peak hour, evening peak hour, noon peak hour, the rest of the day), based on the social-economic data as well as the household study data, the number of trips has been estimated.
	Matrix estimation	Using a simultaneous distribution and modal split model, OD matrices have been derived for each time period (for cars and PT)
	Matrix calibration	The OD matrices have been calibrated in a simultaneous way considering all time periods and using traffic counts from data collection phase I. This is executed separately for car and public transport.
	Assignment technique	<ul style="list-style-type: none"> <li>- Freight: based on generalized costs and 'all or nothing' and countings</li> <li>- Car: based on generalised costs, capacity restrained ('volume averaging') including junction modelling, counting</li> <li>- Public transport: distance to routes, countings</li> </ul>

The output of the modelling exercise has provided a proper base-scenarios and networks that have been transferred to the MOVE Meter. The MOVE Meter is a tool developed to support decision-making in urban development in general, and in transport planning. It provides an insight into the characteristics of the mobility system of a city, being able to analyse a variety of indicators and scenarios that can influence a city's liveability and accessibility. The tool uses the same data that is generally available in a transportation

model, but due to its GIS/internet applicability and its advanced user interface, it is more capable of assessing and evaluating scenarios swiftly and easily (within minutes), saving time and costs. The input data is translated into results that will contribute to finding informed and cost-effective solutions. The visual representation is easy to read and interpret and helps to understand the main problems and analyse their causes. The MOVE Meter can be seen as a dashboard by which the data (the transport model) can be explored and evaluated.

Analyses that the MOVE Meter can perform are, among others: origin-destination matrix analysis, share of short trips on the network, number of short trips on the network, isochrones from/to a certain area, traffic volumes, etc. This analysis performed with the MOVE Meter, as well as other indicators derived from other sources are presented in the following section.

### **Modal split and mode choice**

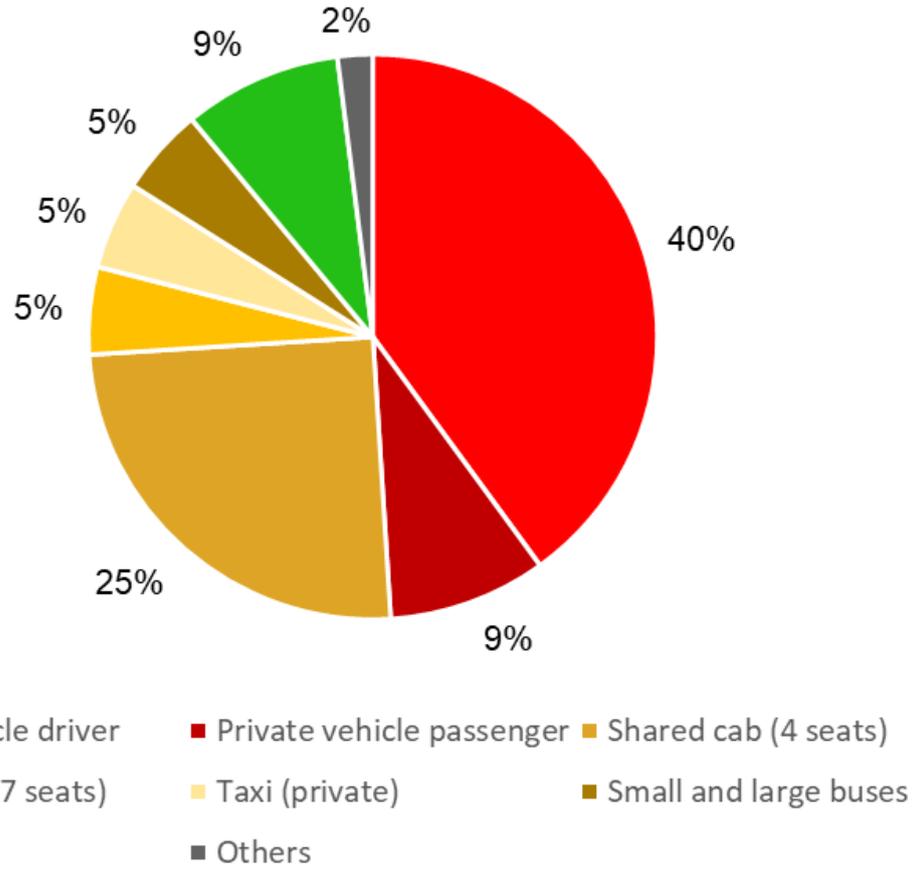
Mode choice is influenced by several factors, grouped in three categories:

- » Characteristics of the trip maker: car availability and/or ownership, possession of a driving license, household structure (young couple, couple with children, retired people etc.), income; residential density.
- » Characteristics of the journey: trip purpose, time of the day when the journey is undertaken.
- » Characteristics of the transport facilities: relative travel time: in-vehicle, waiting and walking times by each mode, relative monetary costs (fares, fuel and direct costs), availability and cost of parking, comfort and convenience, reliability and regularity, protection, security.

Because of the multitude of influencing factors, cities display a very high variation in their modal split. Some cities are more favourable to walking, others have a dense and reliable public transport system, and others encourage private car usage, by providing the most facilities and space to this mode. In general, in Bethlehem, motorised transport has a very high share of almost 91%. Walking represents only 9% of the trips. It is important also to understand the split of the motorised trips. Out of all trips, around 49% are represented by private vehicle, the shared cabs (4 seats) represent a staggering 25% of all trips, and the rest is split between 7 seats shared taxis, small and large buses. It is interesting to notice that cycling is inexistent, due to the lack of infrastructure, the declivity of some streets and the extreme weather conditions especially during summer months. Moreover, scooters and motorcycles are also not represented in the modal split.

Figure 15. Modal split – all trips within the study area.

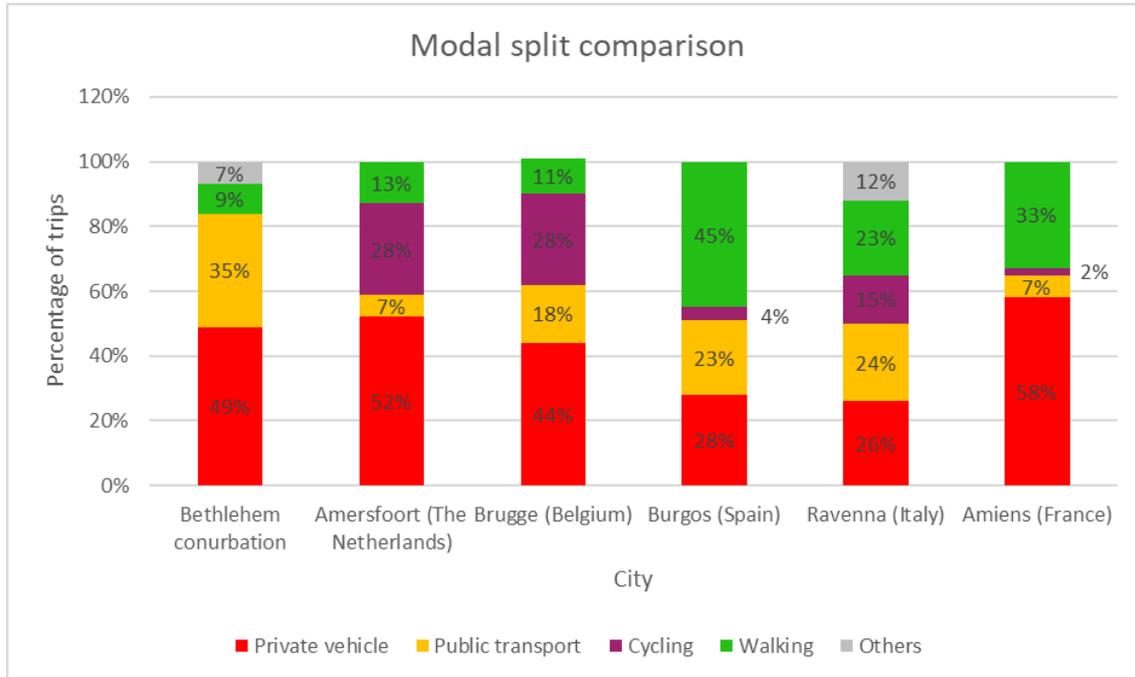
Modal split in the study area - all trips



Source: CDG/ARIJ, 2017<sup>42</sup>

<sup>42</sup> CDG/ ARIJ, (2017), p. 10

**Figure 16.** Modal split comparison analysis of cities similar in size with the study area



Source: CDG/ARIJ, 2017<sup>43</sup> and [http://www.epomm.eu/tems/compare\\_cities.phtml](http://www.epomm.eu/tems/compare_cities.phtml)

Further on, at municipality/locality level, the modal split presents striking variations. For example, the highest share of private vehicle use can be found in Beit Sahur, with 58%, while the refugee camps have the lowest share (8% in Al 'Aza Camp and 12% in Ad Duheisha Camp). The same goes for variations in public transport, mainly related to availability of services, proximity to PT routes, but also income and quality of life level. Thus, the above mentioned two camps exhibit the highest share of public transport – 68% Al 'Aza and 72% in Ad Duheisha. In general, walking has a very low share in most of the localities, with as low as 3% in Beit Sahur and Ad Doha, 8% in Beit Jala, and 36% in Artas (the highest share). Other modes – private taxis, motorcycles, and bicycles have a relatively small share everywhere. The overview of modal split per locality (based on the household surveys) can be seen in **Figure 17**.

When it comes to mode choice by trip purpose, there are also many variations. Surprisingly, going to school and to work have the smallest private vehicle share (only 16% of the school trips and 45% of work trips are done by car). On the other hand, leisure, recreation, shopping, visiting friend and family all have a high share of private vehicle trips. It is important to mention that only 7% of the school trips are done by school bus (since there are no specific services in this sense). Walking is a popular mode choice for school trips, with 48%, but with striking low shares for leisure, recreation and shopping and work – 8%, 6%, 10 % respectively. Private taxis have the highest share for friends and family visits, but otherwise negligible ratios. Public transport is rather unpopular between students and pupils, with a share of 19%. The overview of the mode choice by journey purpose can be found in **Figure 18**.

<sup>43</sup> CDG/ARIJ, (2017), p. 10

Figure 17. Modal split per locality in the study area

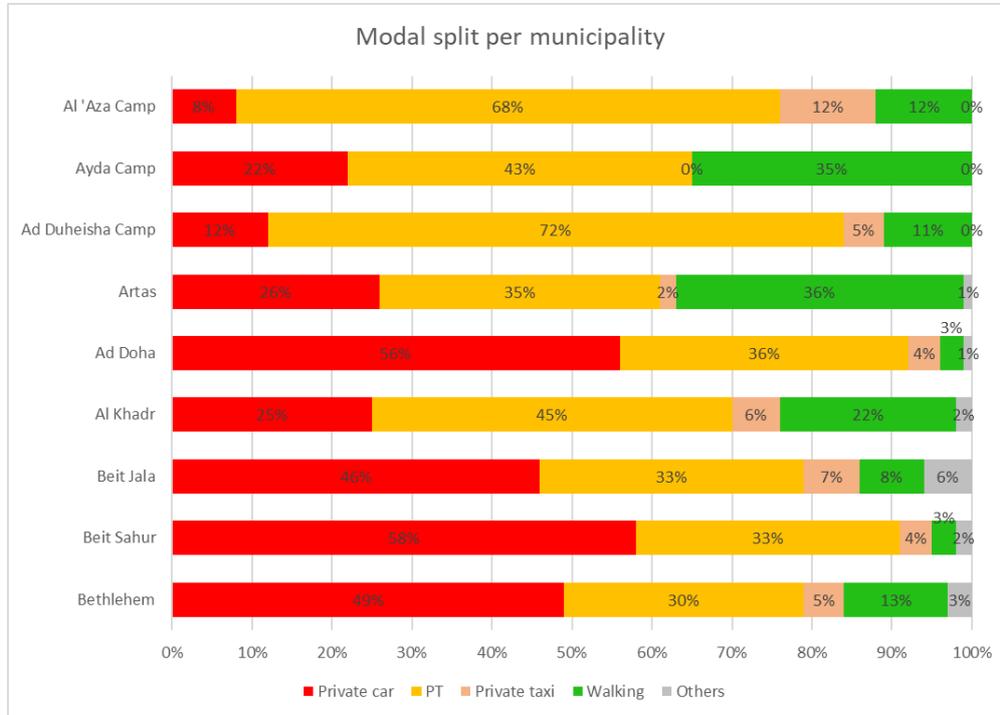
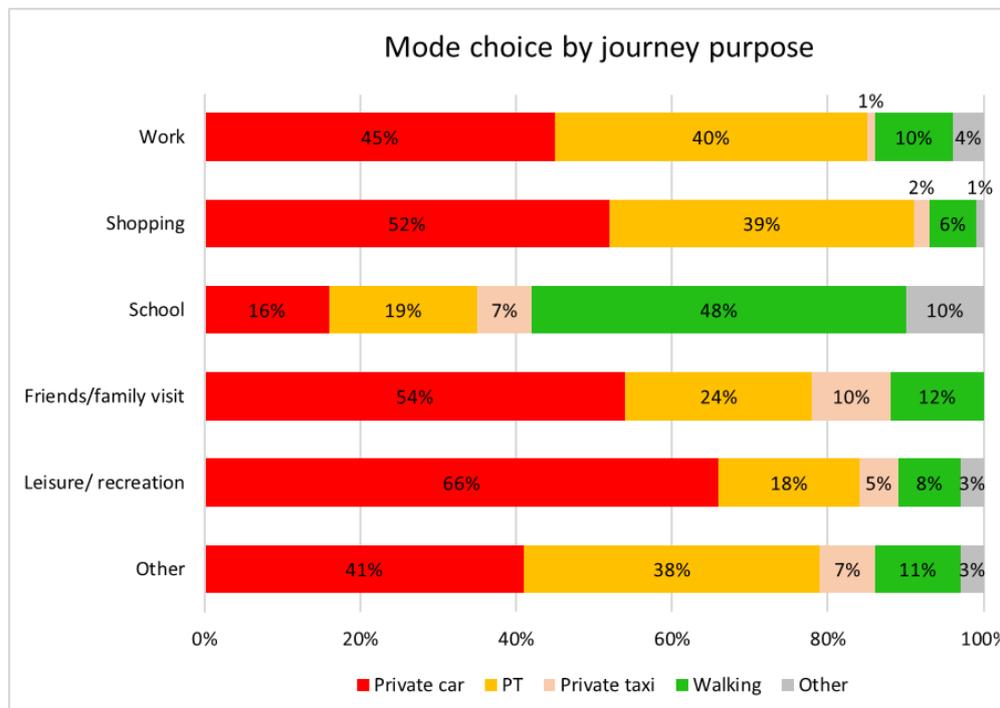


Figure 18. Mode choice by journey purpose



**Main network characteristics**

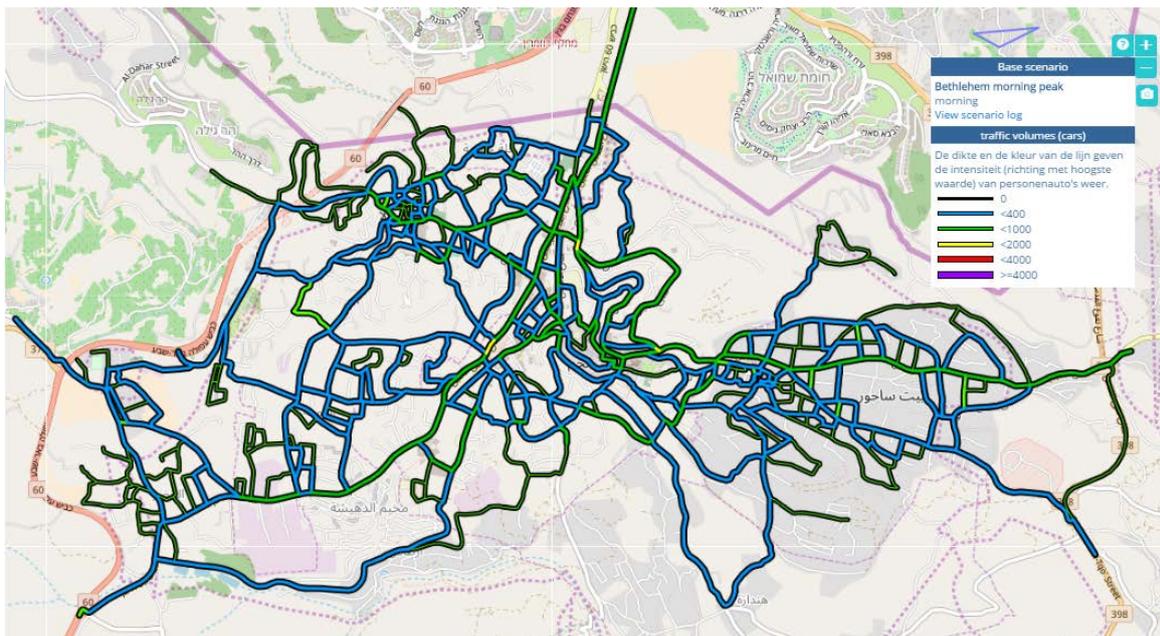
By feeding all collected data into the modelling tools, several characteristics of the network have been obtained, such as: modelled speeds, volumes on the network, modelled capacity. These characteristics can be used to perform various analysis for understanding the problems that the traffic is facing in Bethlehem, during peak periods and throughout the day.

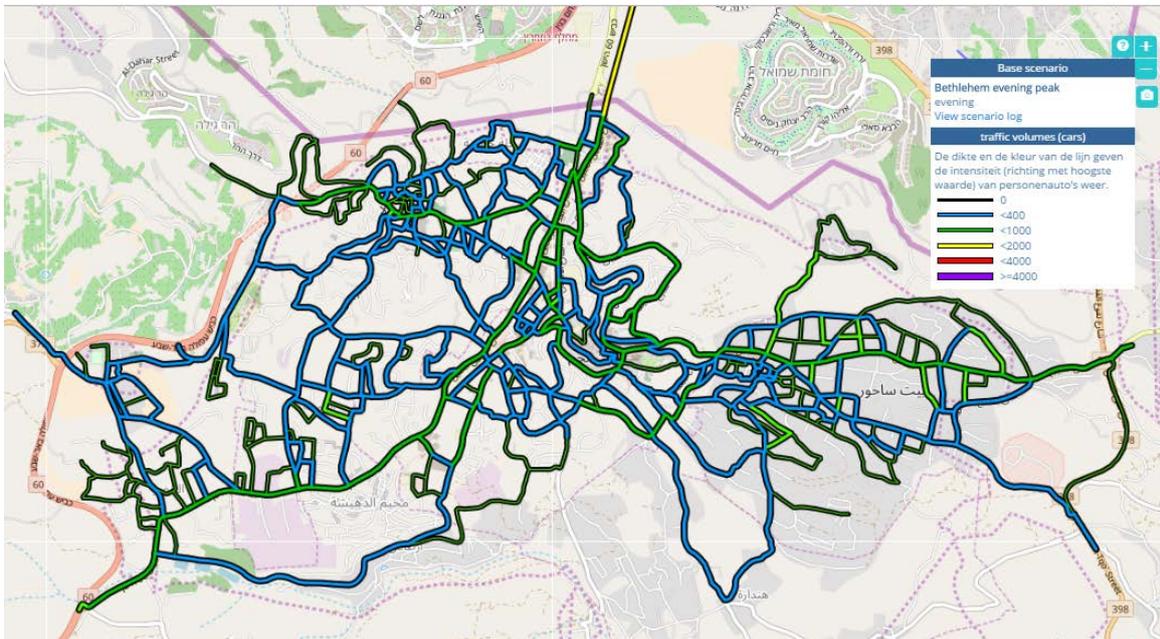
» Traffic volumes on the network

Traffic volume is an important basis for determining what improvements, if any, are required on a road or street facility. Traffic volumes may be expressed in terms of average daily traffic or design hourly volumes. The following maps show the traffic volumes (the number of vehicles) on each link of the network during morning peak hour and evening peak hour. The volumes consist of private vehicles and freight.

By analysing **Map 18** it can be seen that, in general, the hourly volumes during morning and evening peak hours are within normal limits. The colour and the thickness of the lines express the numbers derived from plotting the counting and the OD matrices on the network. With very few exceptions, on most links there are less than 1000 vehicles per hour (green links) and in many cases even less than 400 vehicles (blue links).

**Map 18.** Traffic volumes during morning peak hour and evening peak hour

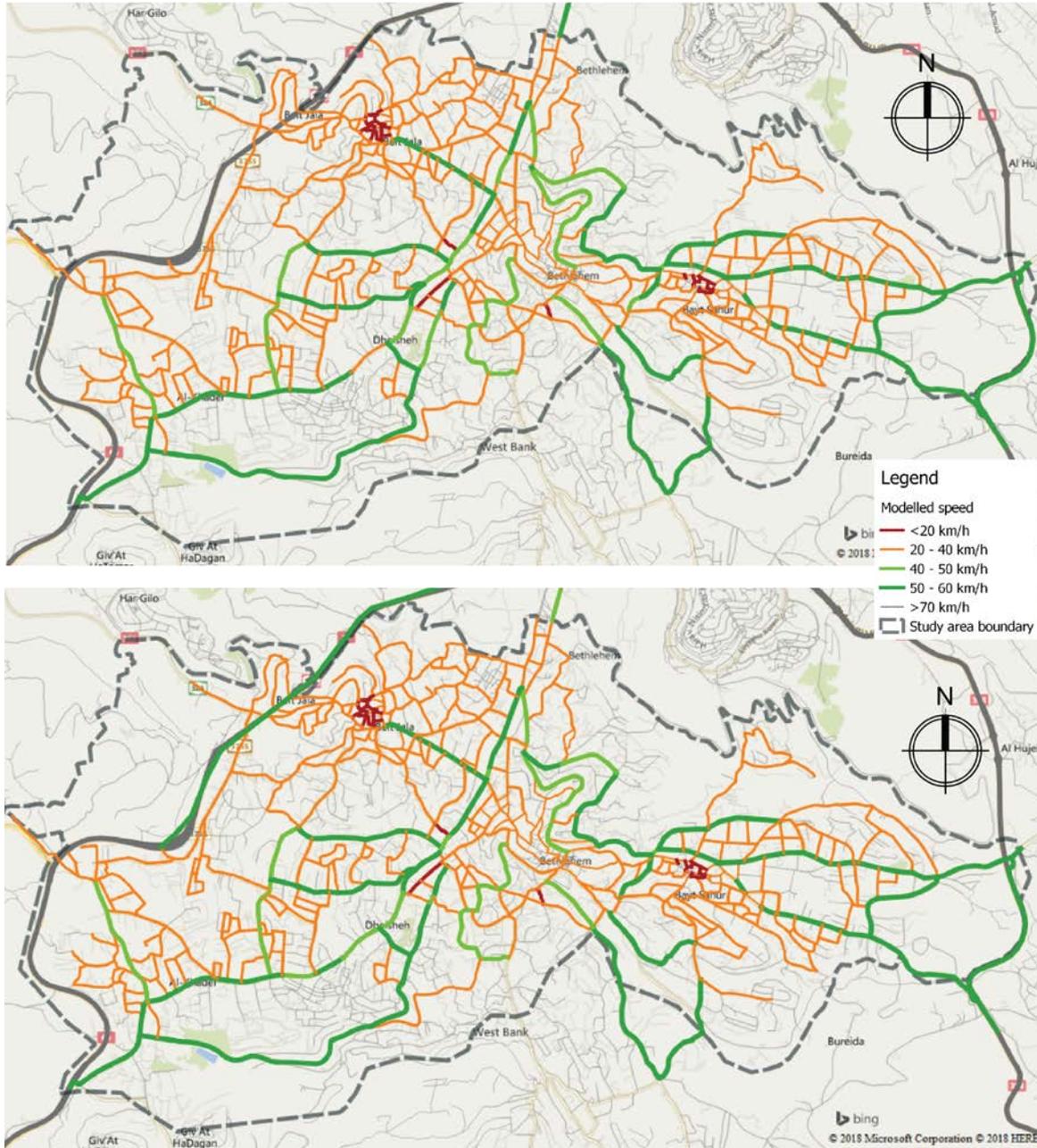




» Traffic speed

Traffic speed is influenced by volume, capacity, design, weather, traffic control devices, posted speed limit, and individual driver preference. For Bethlehem, based on the field work and data collected which was fed into the modelling tools, the modelled speeds on the network show no significant variation compared to the legal speed (*Map 8*) or the free-flow speed. Free-flow speed is the term used to describe the average speed that a motorist would travel if there were no congestion or other adverse conditions (such as bad weather). *Map 19* presents the modelled speed for the morning peak hour (from 7:00 to 8:00) and the average daily speed on the network (the values represent the average of both directions of travelling). It can be easily noticed that there are no significant variations except for some portions of the Hebron Jerusalem Road, Children Street, in the proximity of the school as mentioned for bottleneck 5 (section 3.6) and some other minor roads. That is also the case if the speed during evening peak hour (16:30 to 17:30) is compared with the average daily speed.

**Map 19.** Traffic speed during morning peak hour and average day speed



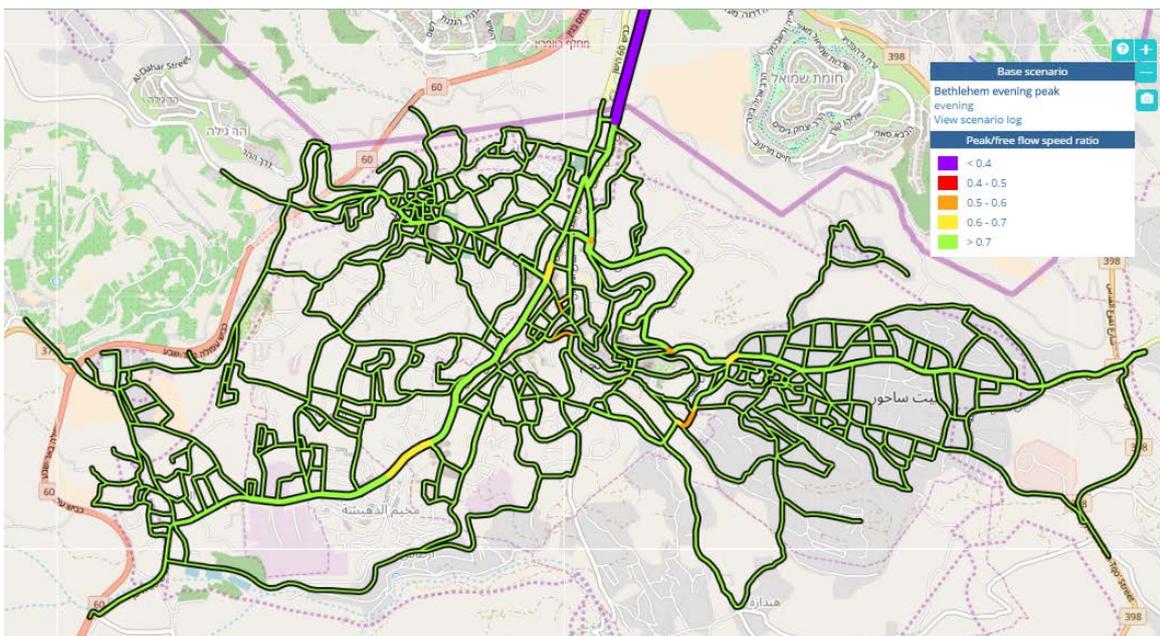
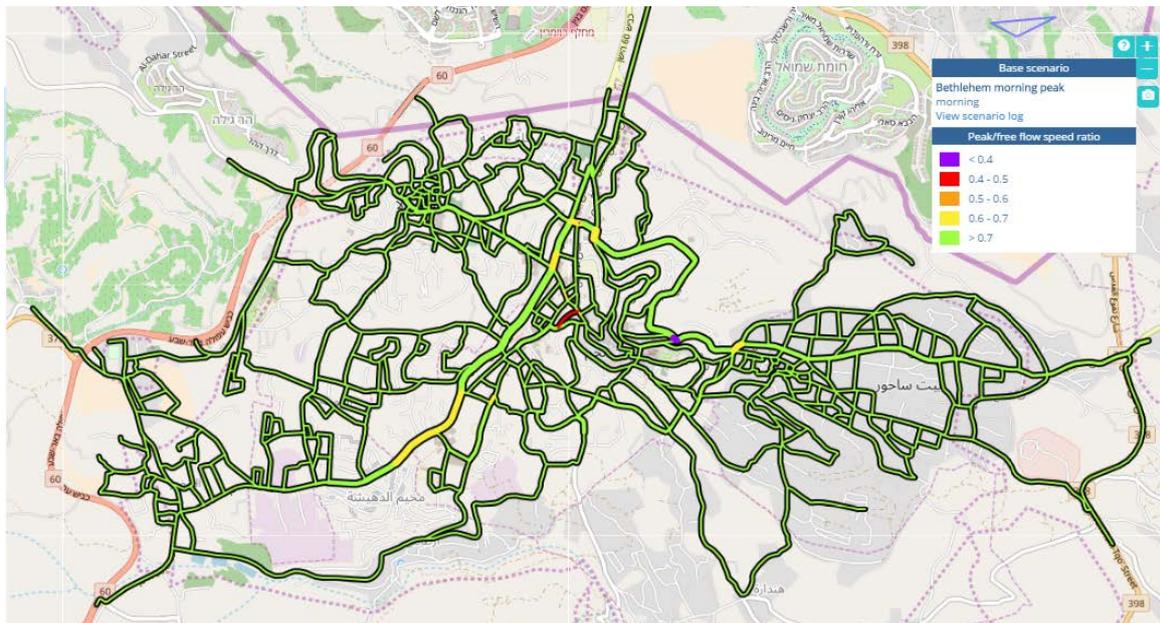
» Congestion

Traffic congestion is a condition on transport networks that occurs as use increases, and is characterized by slower speeds, longer trip times, and increased vehicular queueing. When traffic demand is great enough that the interaction between vehicles slows the speed of the traffic stream; this results in some congestion. Congestion can be measured by using various indicators such as volume/ capacity ratio (V/C) or peak hour/ free-flow speed ratio. For understanding the congestion situation in Bethlehem during rush or peak hours, some congestion classes can be established, based on these ratios.

Peak hour/ free-flow speed ratio characterises congestion and traffic conditions as follows:

- < 0.4 – highly severe congestion
- 0.4 – 0.5 – severe congestion
- 0.5 – 0.6 – congestion
- 0.6 – 0.7 – light congestion
- > 0.7 – no congestion

**Map 20.** Peak hour/ free-flow speed ratio during morning peak and evening peak hour



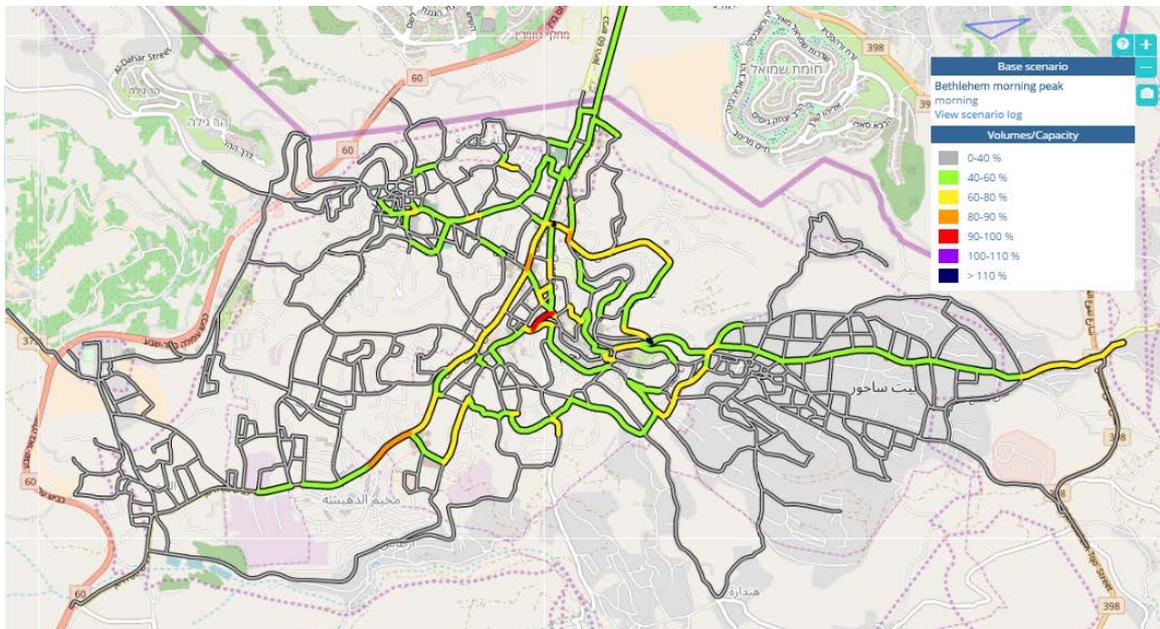
By analysing the data, it can be concluded that there are some segments of road within the study area that suffer from congestion or delayed travel time due to reduced travel speed. These are mostly related to busy or difficult intersections - such as the Nissan roundabout (on Manger Street), the intersection between Al Sahel Street and Hebron-Jerusalem Road, Hebron – Jerusalem Road next to Ad Duheisha camp and so on. The most problematic road in terms of travel speed is the road exiting/ entering the study area nearby Checkpoint 300. Nevertheless, the problematic areas are punctual, supporting the previous statements that Bethlehem conurbation is not facing severe structural congestion, but mostly incidental congestion related to bottlenecks, as detailed also in section 3.6.

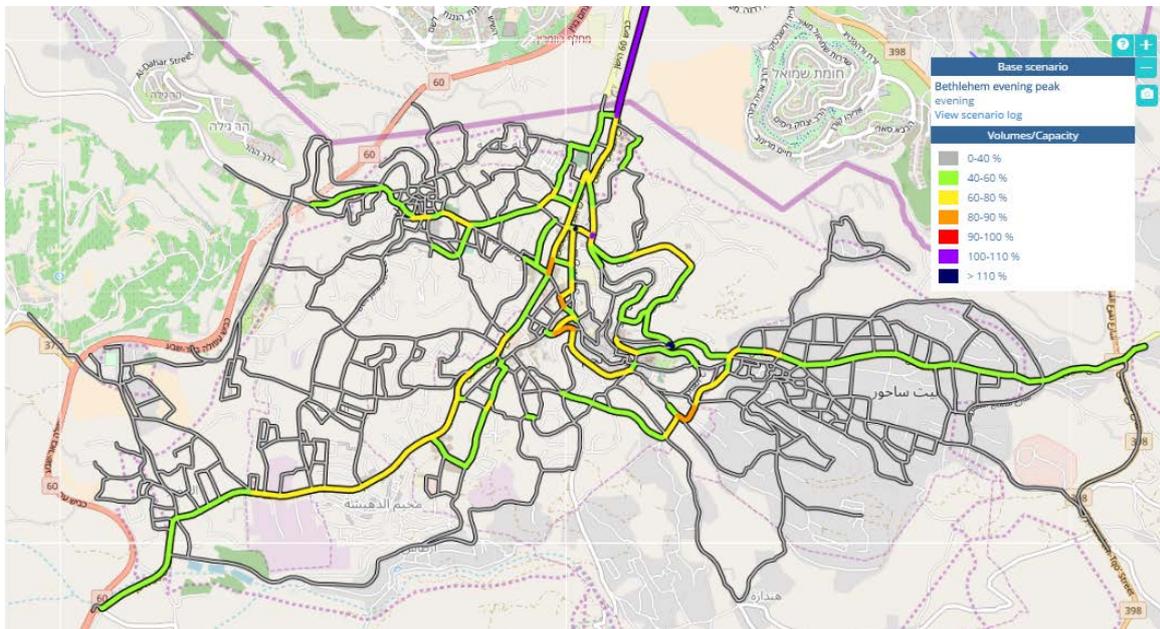
Volume/ capacity ratio is a measurement of the operating capacity of a roadway or intersection where the number of vehicles passing through is divided by the number of vehicles that could theoretically pass through when at capacity. If vehicles (v) divided by capacity (c) is less than one the facility has additional capacity and there is no congestion or delay observed. The following classes can be distinguished:

- < 0.6 (60%) – no congestion, light traffic
- 0.6 – 0.8 (60 – 80%) – traffic on the move
- 0.8 – 1.0 (80 – 100%) – light congestion
- > 1.0 (100%) – congestion.

**Map 21** shows the current situation in Bethlehem, related to the V/C ration on the links of the network. In general, with very few exceptions (the entry/ exit point at Checkpoint 300) the V/C ratio is below 1.0 (or 100%). Nevertheless, during both morning and evening peak hours the main roads of the network are used at about 60 to 90% of their capacity (light and dark orange). Such is the case of most sections of Hebron – Jerusalem Road, Manger Street, Al Al Sahel Street, some sections of the main road in Beit Sahur.

**Map 21.** Volume/ capacity ratio (v/c) during morning peak hour and evening peak hour





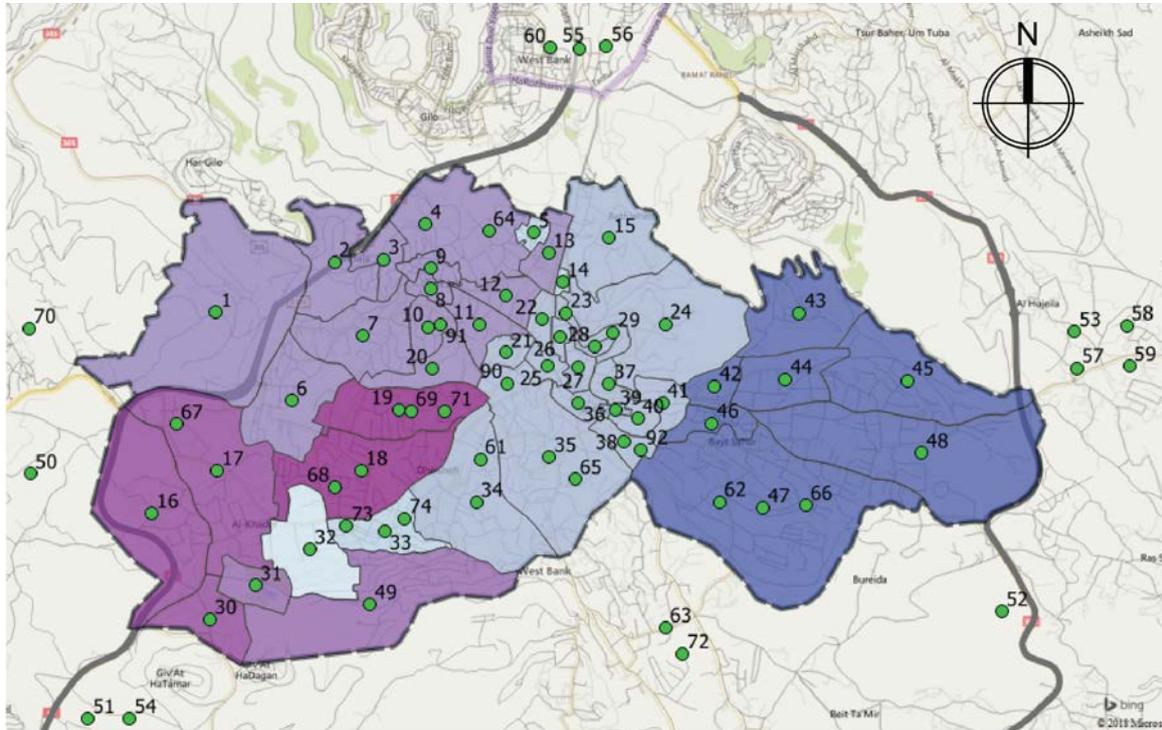
Although severe congestion is not present at this moment (the base scenario is calculated for the 2017 situation), if the population and car ownership rates follow the current growth trends, the traffic on some of the roads will exceed their capacity in the following decades, if no significant interventions are to be done, concerning modal share, change of behaviour and mode choice. It is also worth mentioning that the volumes shown on these maps do not include public transport trips, which add on average between 20 and 40% additional trips on the designated PT routes, as shown in section 3.7.

### Zoning

As part of the modelling process, the zoning produced during Phase I: Data Collection has been refined and adjusted to accommodate more zones, thus a more detailed trip assignment and OD matrix. The new assignment and zoning have been performed based on previous data gathered, thorough analysis of satellite imagery (density of buildings, density of roads, heights of buildings) and local knowledge and expertise.

*\*Note: The external zones do not represent the exact geographical location, since most of the time they are either a locality placed at a far distance or an aggregated zone of multiple localities (such is the case for the rural areas around Bethlehem). Instead they are placed nearby the main road that connects them with the study area, e.g. the traffic from Jericho, Nablus and Ramallah discharges on the main road in Beit Sahur, whereas the one from Hebron connects on the network through the south-western entrance, on the Hebron-Jerusalem Road.*

Map 22. Zoning for modelling and coding of zones\*



Legend

- Zones
- areas
- Ad Doha
- Al Khader
- Artas
- Beit Jala
- Beit Sahur
- Bethlehem
- Camp
- Industrial

Internal areas	Zones
Ad Doha	18,19,68,69,71
Al Khader	16,17,30,67
Artas	31,49
Al 'Aza Camp	14
Beit Jala	1-13, 20,64,91
Beit Sahur	42-48,62,66,92
Bethlehem	15,21-29,32,33-41,61,65,90
Ad Duheisha Camp	73,74
Ayda Camp	5

External area	Zones
Hebron	54
Jericho	57
Nablus, Tulkarm, Jenin, Jericho	59
Ramallah	58
Jerusalem	55,56
Israel	60
Western rural areas	50
Southern rural areas	51,63,72
Southeastern rural areas	52
Northeastern rural areas	53
Northwestern rural areas	70

Main trip attractors and generators

For analysing the current situation, determining the challenges related to traffic and the future development of the traffic in the following decades in the study area, it is important to understand the main attractors and generators of trips within Bethlehem conurbation and around it. The data reflects the counting and OD matrices developed during Phase I: Data Collection, plotted on the network through an iterative process with the modelling tools (OmniTRANS and MOVE Meter).

Map 23 shows a comparative analysis of the main attractors and generators of trips (on a Thursday), during morning and peak hour, based on the zoning shown above. During morning peak hour, the main attractors are situated in Bethlehem and Beit Jala municipalities, where most jobs and commercial areas are situated. The situation is very different during evening peak hour, with the zones situated in Israel generating and attracting many trips. This is because Thursday evening is the start of the weekend in Israel, and as mentioned in section 3.6, when describing bottleneck 1 (Checkpoint 300), a large number of the Palestinians living in Israel (Palestinians of 48) are coming to Bethlehem to visit their families and friends, or for shopping and leisure.



**Table 20.** Trips generated and attracted by mode of transport in the study area on a 24 h basis (an average working week day – Thursday)

Locality	Private vehicles		Freight		and external)		TOTAL
	Generated	Attracted	Generated	Attracted	Generated	Attracted	
Ad Doha	12,636	8,691	372	439	8,123	5,587	35,848
Ad Duheisha Camp	3,828	5,399	122	273	22,967	32,394	64,983
Al Aza Camp	1,364	768	37	137	11,591	6,527	20,424
Al Khader	6,934	9,027	422	416	12,481	16,248	45,528
Artas	3,161	2,994	105	109	4,255	4,031	14,656
Beit Jala	31,670	30,004	1,842	1,805	22,720	21,607	109,648
Beit Sahur	19,233	21,225	868	883	10,943	12,076	65,229
Bethlehem	66,413	74,202	2,836	2,777	60,807	61,294	268,329
Eastnorth zone	1,819	1,764	102	69	1,170	2,014	6,937
Hebron	2,499	1,725	152	100	3,265	4,381	12,122
Israel	2,343	93	111	133	653	54	3,388
Jericho	358	450	102	69	63	45	1,087
Jerusalem	1,893	718	111	133	N/A	N/A	2,856
Jerusalem Munic. Boundary	6,759	6,145	111	133	2,857	2,104	18,111
Nablus, Tulkarm, Jenin, Jericho	94	7	102	69	0	535	807
Northwestern rural areas	1,143	1,111	91	148	N/A	N/A	2,494
Ramallah	2,000	1,462	102	69	308	463	4,404
Southeast Zone	1,191	582	36	58	2,449	5,079	9,395
Southern rural areas	3,503	3,122	321	215	N/A	N/A	7,161
Southern Zone	447	283	152	100	2,295	1,950	5,228
Western Zone	1,012	528	152	100	2,694	3,365	7,851
<b>TOTAL</b>	<b>170,300</b>	<b>170,300</b>	<b>8,253</b>	<b>8,236</b>	<b>169,642</b>	<b>179,756</b>	<b>706,488</b>

**Table 20** presents an overview of number of trips generated and attracted by each locality in the study area, as well as those produced by the external zones (as described in **Map 22**). The numbers are expressed in person-trips (round trip). The numbers have been obtained by processing the counting, OD matrix and other information collected in the previous phase. Since data was available only for peak hours (morning, evening and afternoon), the 24 hours values have been obtained by considering the following approximate split per day: morning peak hour, noon peak hour, evening peak hour – each 10% of total daily traffic, the rest of the day – 70%. These factors have been uniformly used for all modes (private vehicles, freight and public transport) for obtaining the total volumes on a 24 h basis. It is also important to mention that the numbers represent both the departure and the arrival of the same trip (a trip is always considered as having 2 components – the outward and the return). In other words, the numbers represent one-way trips, meaning that the trip to a primary destination represents one trip and the return trip represents a separate trip.

The public transport number has been deducted through several operations, since public transport related data collected was scarce (especially regarding internal trips). The difficulty comes also from the way the PT is organised, without predefined schedules, stops and clear routes. Therefore, for obtaining the number of internal PT trips, the modal split by locality has been used (**Figure 17**), applied to number of private vehicle trips as obtained from the modelling of the OD matrix/ counting. For deducting the number of external PT trips, the OD matrices and counting performed during the previous phase have been processed. Furthermore, for some zones information is missing (such as data for PT trips from and to the north-western

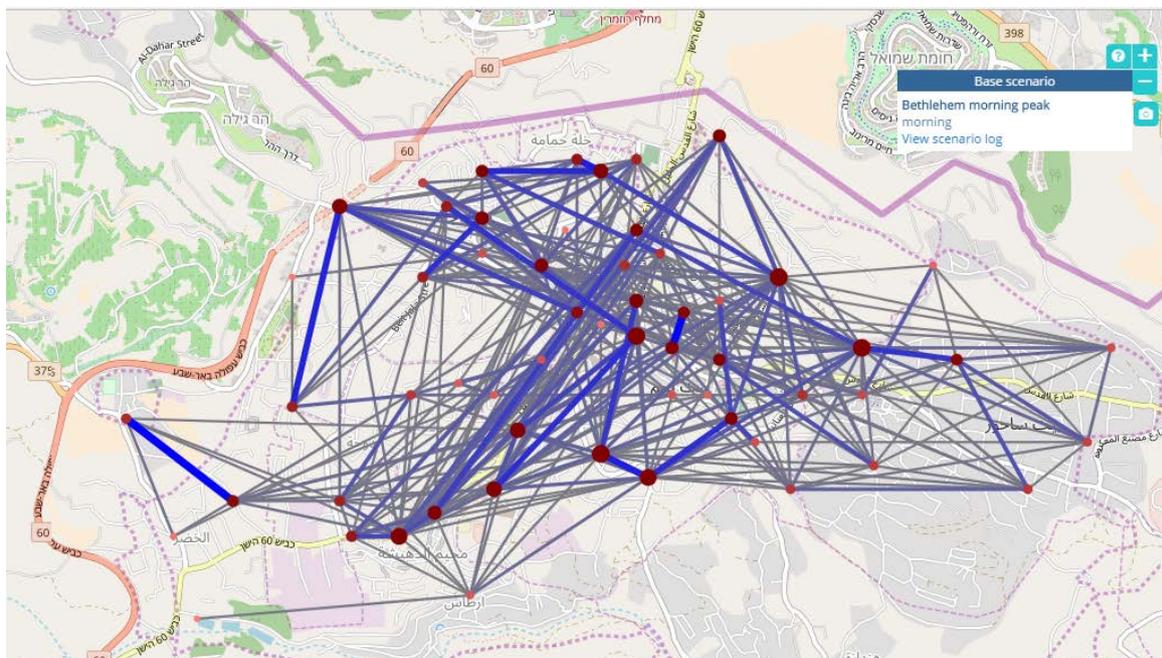
and southern rural areas). Also, trips coming and going from various places in Israel have all been aggregated for zone 60. In total, there were around 36,000 external public transport round trips (72,000 as expressed in the table), representing around 21% of the total public transport trips. It is important to understand that the numbers for public transport represent person-trips (as stated above) and not vehicles (which can accommodate 4, 7, 20 or more persons).

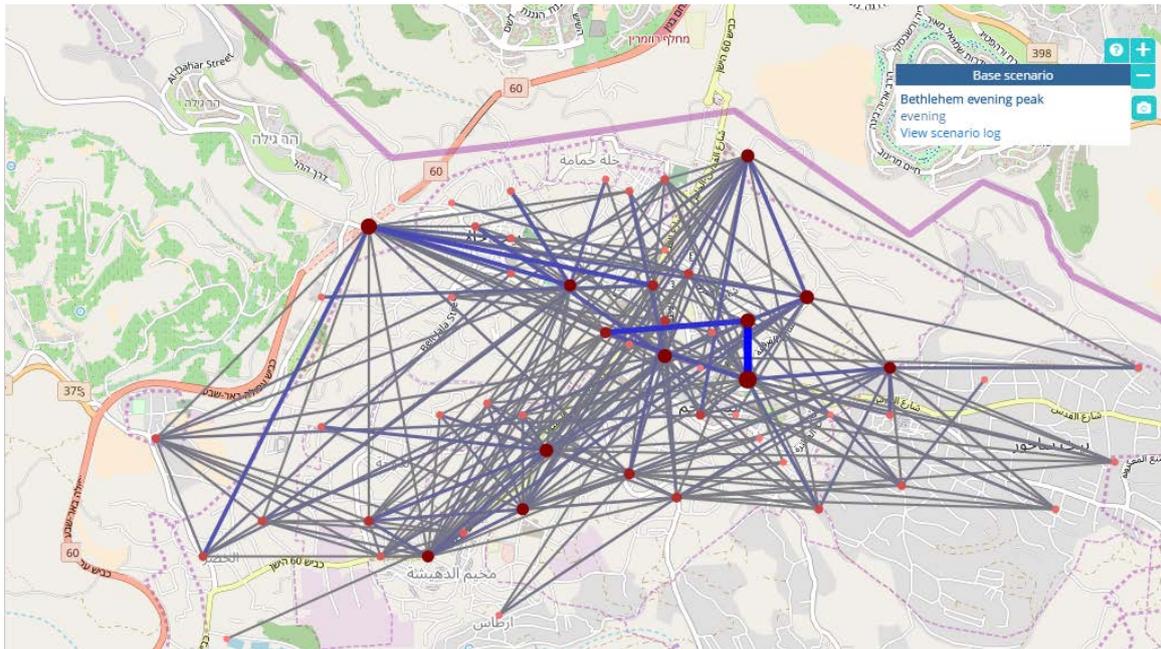
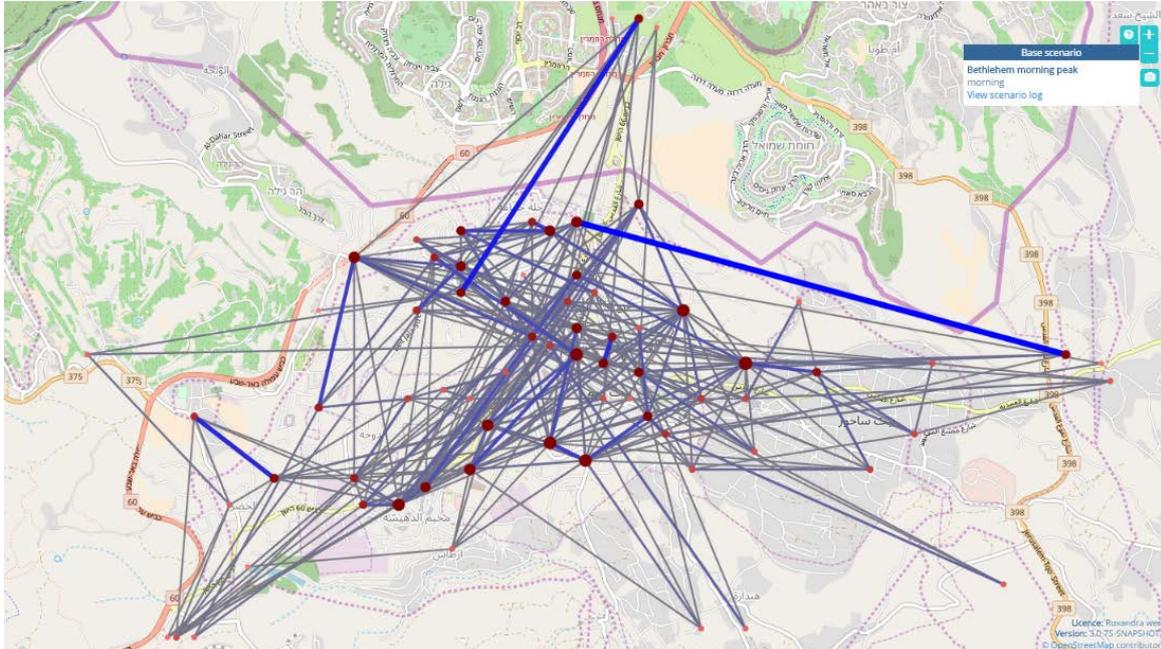
By analysing the numbers, it can be concluded that Bethlehem is the biggest generator and attractor of both private vehicle and public transport trips, accounting for about 38% of the total trips. This is to be expected, given the size and the importance of the municipality within the study area and for the region. Bethlehem Municipality is followed by Beit Jala and Beit Sahur accounting for 15.5% and 9 % of the total trips, respectively.

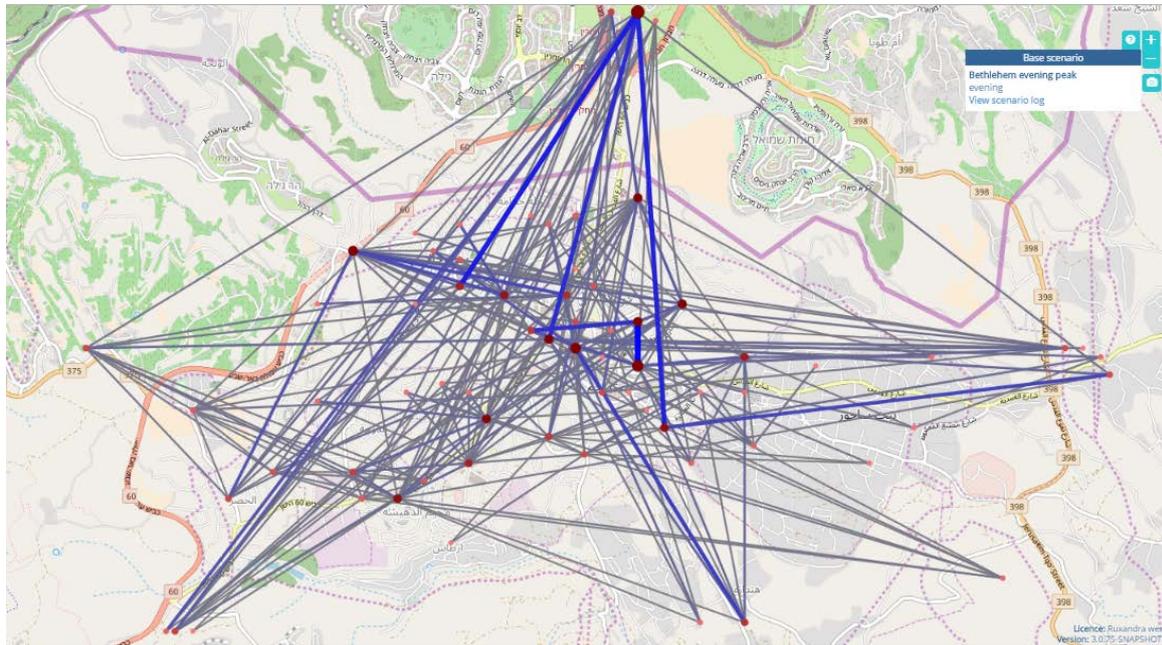
The relationships between various zones (and localities) within the study area and between internal and external zones, as expressed also in the table below can also be visualised as an OD matrix analysis performed with the MOVE Meter. **Map 24** show the strength and the size of the trip generation and attraction between various zones (internal and all trips) during peak hours. The thickness of the lines represents the strength of the relation between two zones (in number of trips) and the size of the dots represent the number of trips generated and attracted by a zone. For both morning, but especially for evening peak it is important to highlight the higher number of external trips coming from Israel through the Checkpoint 300. During morning peak, the number of external trips coming from the east and northeast is also particularly high.

Understanding the routes mostly used by private vehicle and the strongest attractors and generators of trips is important for determining where interventions related to public transport and walking can be most effective.

**Map 24.** OD matrix analysis for internal personal vehicle trips (minimum 5 trips per relationship) and for all trips (minimum 10 trips per relation) during morning peak hour and evening peak hour



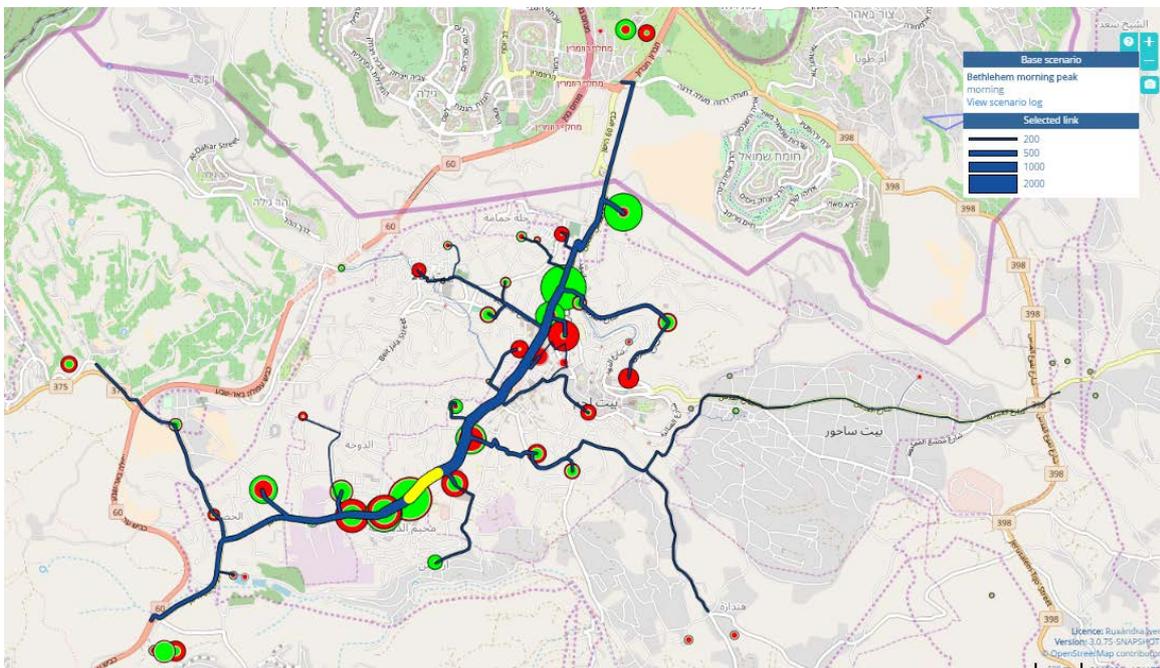
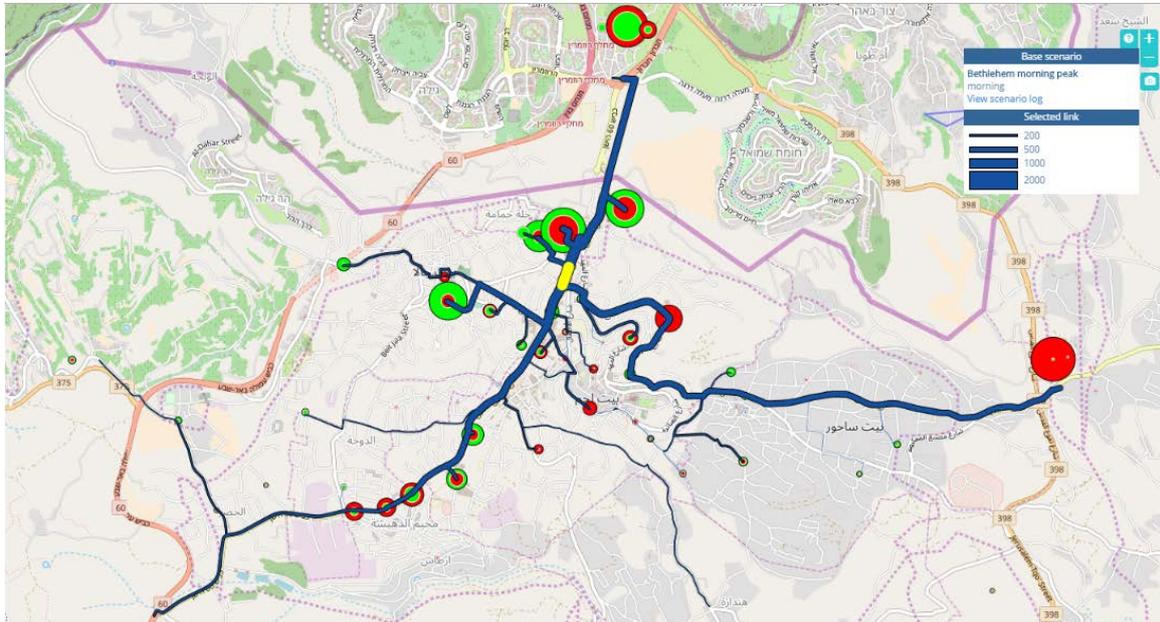


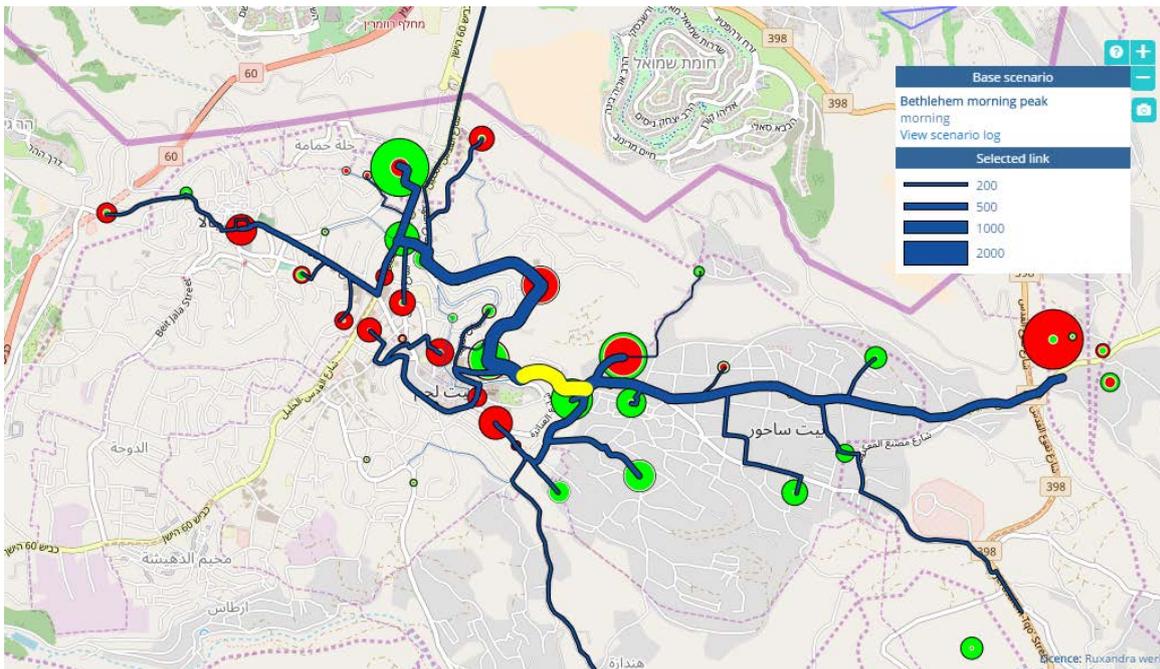
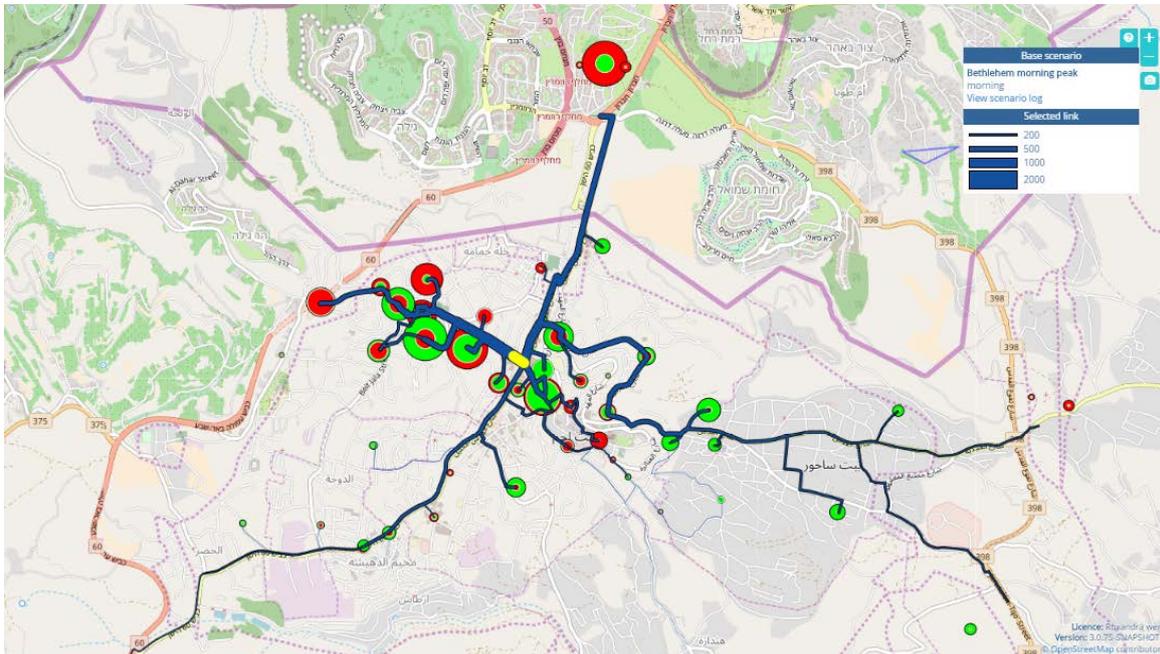


To further understand the traffic situation in the study area and the importance of main attractors and generators of trips in relation to the network capacity and quality, several other analyses can be performed. “Selected link” analysis provides information about where traffic comes from and goes to a location. This is a useful tool for determining which origin-destination relationships contribute to the emergence of bottlenecks. For this study, several links (on major roads) have been analysed.

*\*Note: The thickness of the blue lines represents traffic volumes (private vehicles and freight). The tool shows the preferred route between various origin and destination relationships. The green spheres represent origins and the red ones destination zones and the size of the sphere indicates the number of trips generated/ attracted by those particular zones. The selected link (that is analysed) is shown in yellow.*

**Map 25.** Selected link analysis for sections of Hebron – Jerusalem Road, Al Al Sahel Street and Beit Sahur main road\*





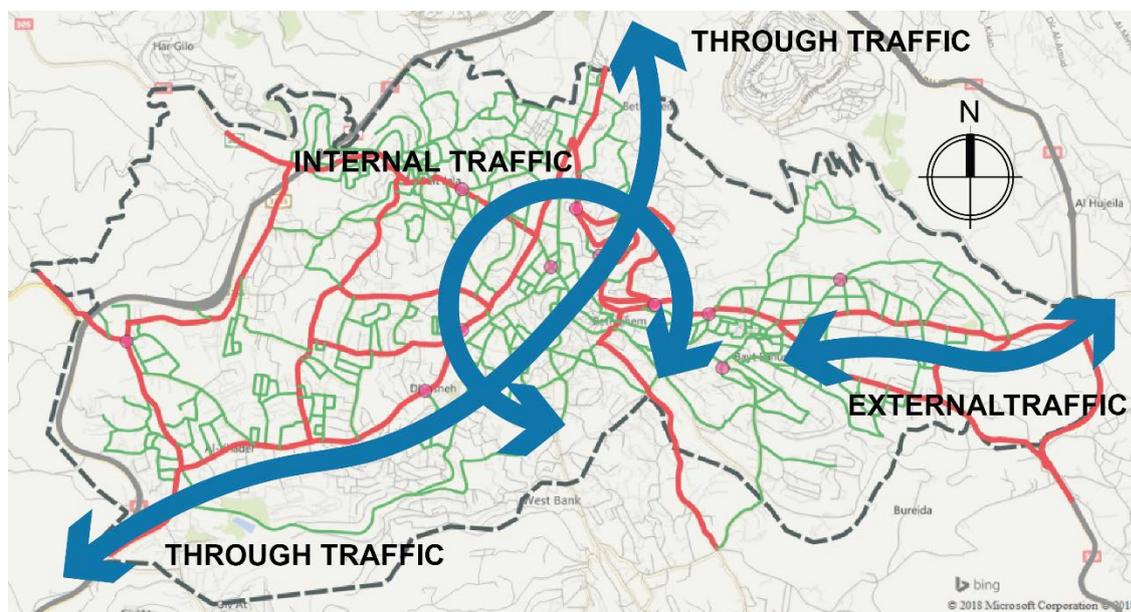
**Traffic type and categories**

Traffic type is an important indicator that can support proper urban and transport decision making. Traffic can be: (1) Internal - trips inside the study area; (2) External - trips from/to the study area to/from other places and (3) through traffic: trips that have no purpose in the study area, but just cross it, due to road configuration and its relation with the locality.

These different types of traffic that are using the road network in Bethlehem conurbation require different approaches. For instance:

- » The internal trips are quite often short (less than 3 km) and have the potential for shifting from car to public transport and walking, thus, shifting to a more multi-modal transport system inside the study area.
- » The external trips are important for the economy of the area because these carry consumers, personnel and goods to the inner areas.
- » Car traffic that goes through the area should be avoided as much as possible which implies a shift towards public transport or segregation in the network (i.e. bypasses, ring roads outside the urban areas). This separation reduces the congestion and pollution in the internal areas. But building bypasses is not always the most efficient or economic sustainable solution, therefore correctly categorising the type of road and the speed on it is an important step. How to tackle this issue will be described in the strategy development phase.

**Figure 19.** Traffic types – internal, external and through traffic scheme



By analysing the data available, it can be seen that Bethlehem is experiencing both external and through traffic, for private vehicles and public transport as well. But they are not posing a great challenge to the traffic situation as, for example, during morning peak hour, from a total number of 18,908, only 2,824 were external or through trips, representing approximately 15% of the total number of trips. In the evening peak hour, the situation is different (especially since data is for a Thursday evening and as explained above a lot of Palestinian that live in Israel are coming to Bethlehem). Thus, during the evening peak hour, external and through trips represent about 39% - 5,558 out of 14,310. The exact number of trips and the percentage they represent out of the total number of trips can be seen in **Table 21**.

**Table 21.** Distribution of internal, external and through traffic (private vehicles) during morning and evening peak hour

	Morning peak hour		Evening peak hour	
	Total trips	Percentage	Total trips	Percentage
Internal traffic	16,083	85%	8,753	61%
External traffic	2,638	14%	4,721	33%
Through traffic	187	1%	836	6%
<b>TOTAL</b>	<b>18,908</b>	<b>100%</b>	<b>14,310</b>	<b>100%</b>

As shown in **Map 24** to **Map 30**, for personal vehicles, the strongest origin – destination relations are between Hebron and Israel (north-south relation) for through traffic. What external traffic is concerned, during morning peak hour, the most trips occur between Jerusalem and Bethlehem and between the north-eastern areas (Ramallah in particular) and Bethlehem.

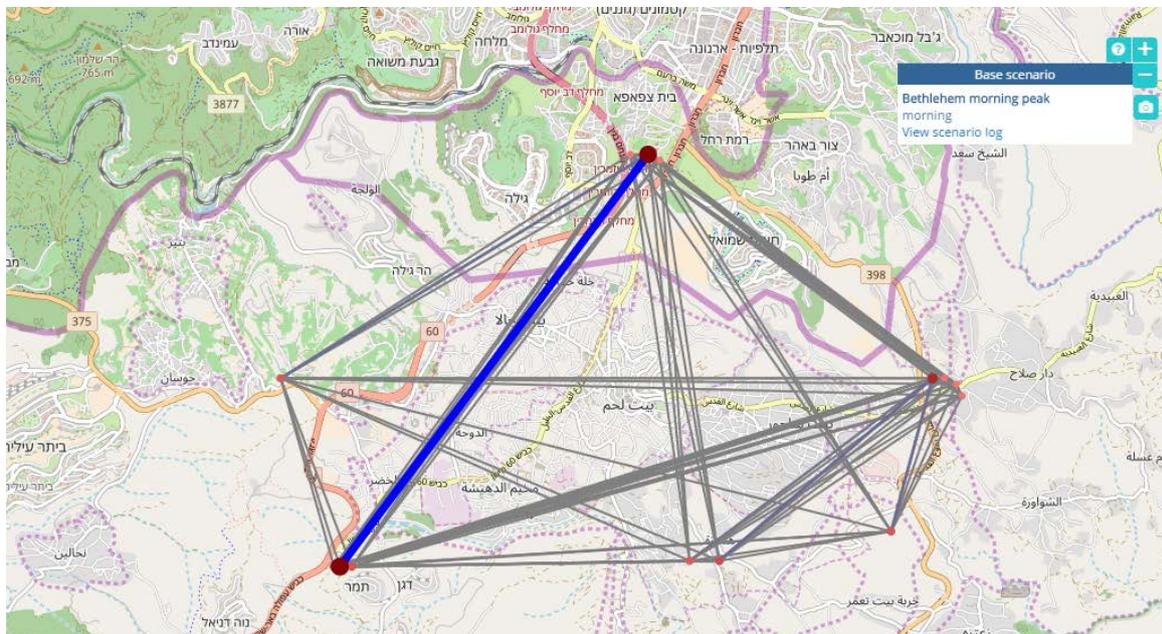
By analysing the data, it can be concluded that through traffic (traffic that does not have an origin or a destination in Bethlehem conurbation) does not actually represent a problem in the study area, accounting for only 1% of the trips during morning peak hour and 6% during evening peak hour. It is possible that this percentages are different during other moments of the day (for example very early in the morning, from 4:00 to 6:00, when people go to work in other localities or commercial vehicles cross the area), but it is not expected that they would exceed 10%.

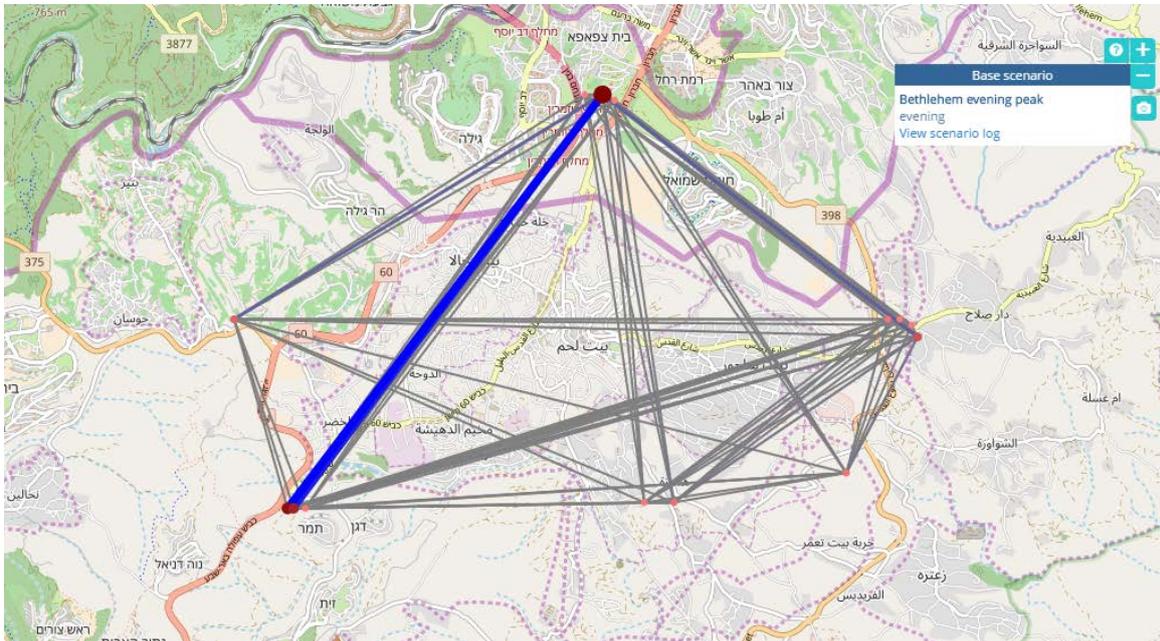
**Table 22.** External and through traffic (private vehicles) per zone/ area during morning peak hour and evening peak hour

Zone	Locality/ area	Through traffic		External traffic		TOTAL non-internal traffic
		Generated	Attracted	Generated	Attracted	
50	Western Zone	3	7	88	18	117
51	Southern Zone	6	2	80	66	155
52	Southeast Zone	7	2	58	94	162
53	Eastnorth zone	1	1	71	120	194
54	Hebron	7	45	133	104	288
55	Jerusalem Munic. Boundary	43	8	133	366	550
56	Jerusalem	1	1	14	81	98
57	Jericho	1	1	24	47	73
58	Ramallah	4	13	16	546	579
59	Nablus, Tulkarm, Jenin, Jericho	1	1	16	8	26
60	Israel	1	1	14	34	50
63	Southern rural areas	2	5	56	138	202
70	Northwestern rural areas	6	2	75	68	152
72	Southern rural areas	8	2	67	102	178
<b>TOTAL</b>		<b>93</b>	<b>93</b>	<b>847</b>	<b>1,791</b>	<b>2,824</b>

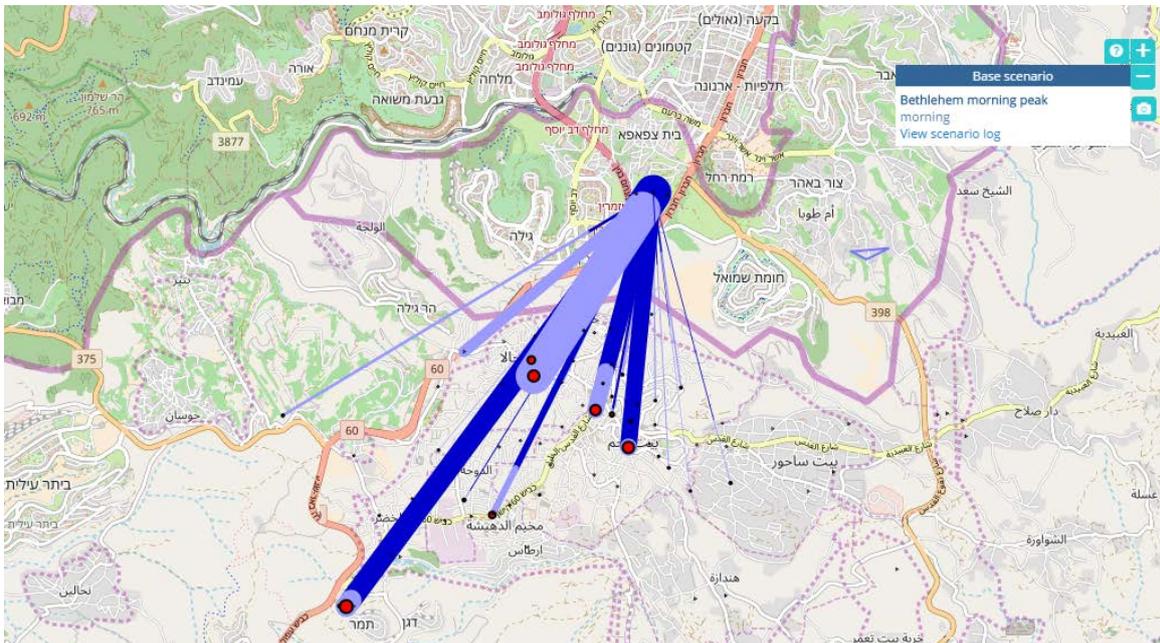
Zone	Locality/ area	Through traffic		External traffic		TOTAL non-internal traffic
		Generated	Attracted	Generated	Attracted	
50	Western Zone	150	5	63	45	263
51	Southern Zone	6	1	34	47	88
52	Southeast Zone	13	7	83	107	209
53	Eastnorth zone	7	58	118	219	402
54	Hebron	112	13	236	125	486
55	Jerusalem Munic. Boundary	59	299	579	772	1,710
56	Jerusalem	2	2	160	14	179
57	Jericho	4	4	92	63	163
58	Ramallah	7	6	346	24	382
59	Nablus, Tulkarm, Jenin, Jericho	4	4	41	7	56
60	Israel	2	2	435	14	454
63	Southern rural areas	4	5	119	61	190
70	Northwestern rural areas	35	2	217	152	406
72	Southern rural areas	13	9	265	283	570
<b>TOTAL</b>		<b>418</b>	<b>418</b>	<b>2,787</b>	<b>1,934</b>	<b>5,558</b>

Map 26. Through traffic (private vehicles) during morning and evening peak

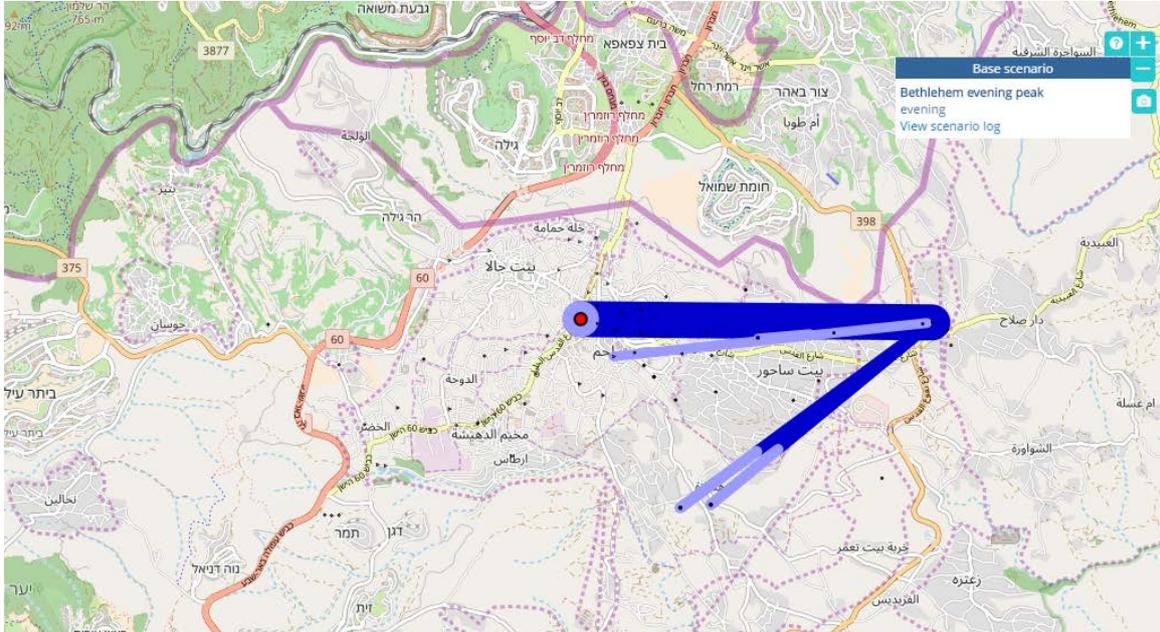




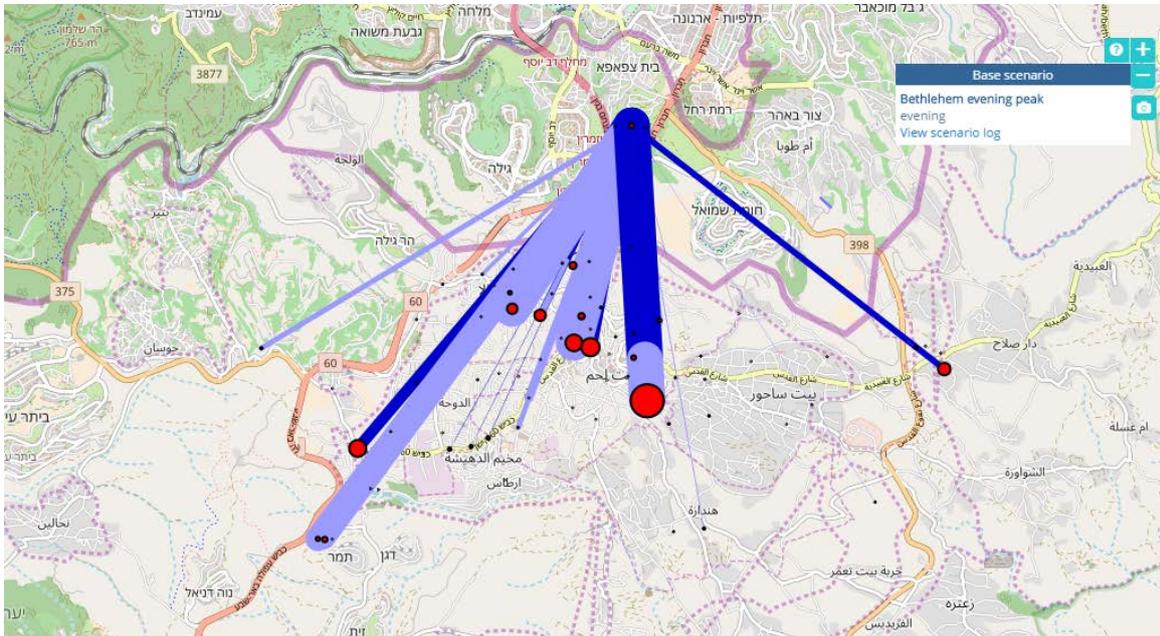
**Map 27.** External and through traffic from Jerusalem during morning peak hour (\*see note below)



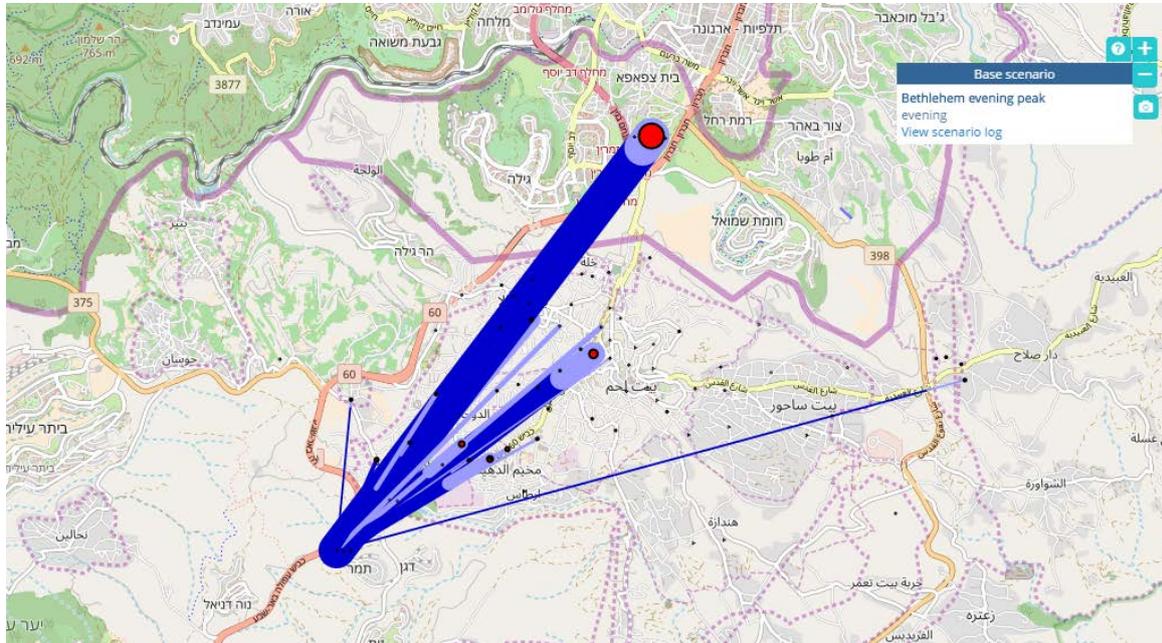
**Map 28.** External and through traffic from Ramallah during evening peak hour



**Map 29.** External and through traffic from Jerusalem during evening peak hour



**Map 30.** External and through traffic from Hebron during evening peak hour

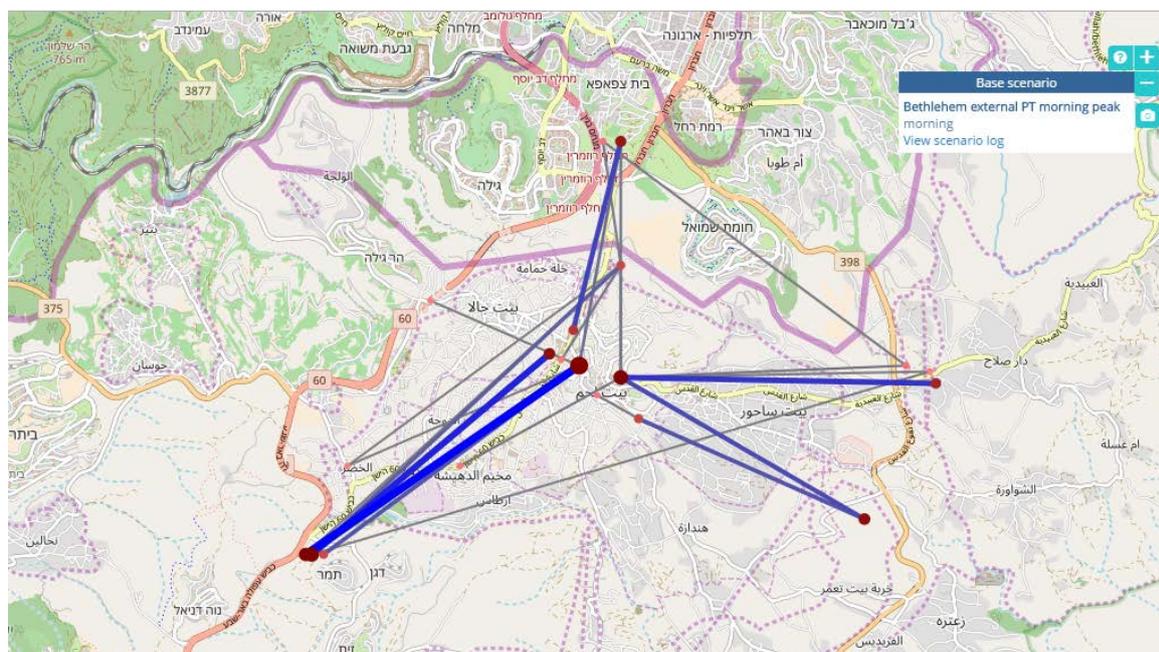


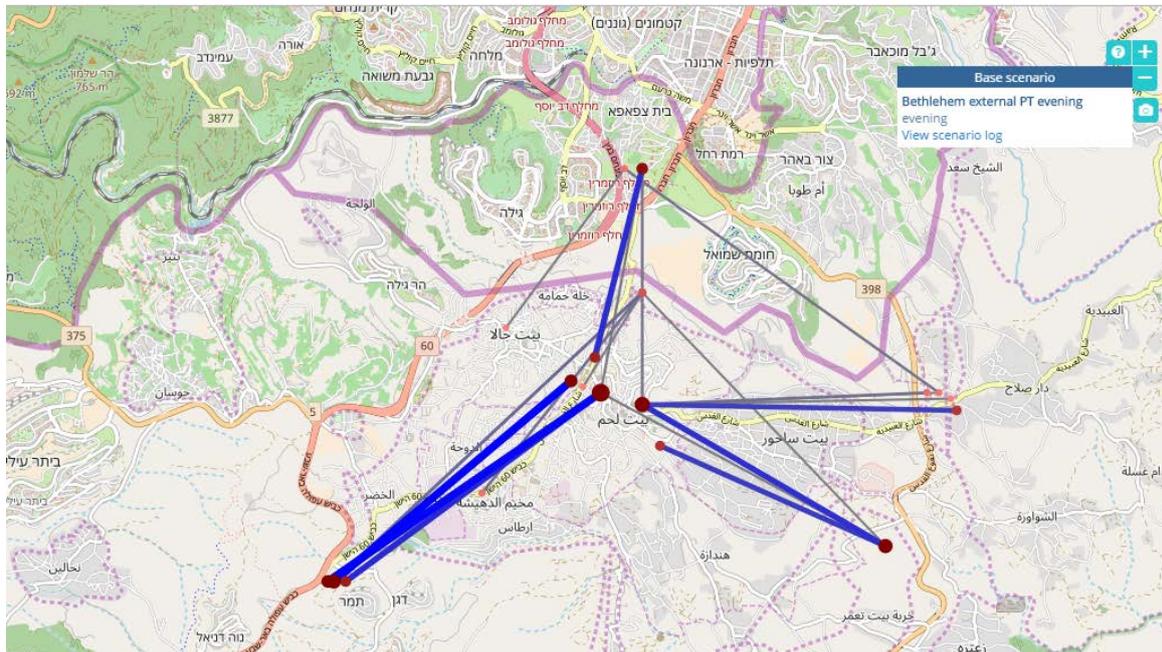
For public transport, the situation is rather different than the one for private vehicles. Based on the collected data, external public transport is producing 3,959 person-trips (round trips, consisting of a departure and an arrival) during both morning and evening peak hour. Since there are no public transport lines that cross Bethlehem area without having a station here, through traffic is not a topic of discussion what PT is concerned. **Map 31** shows the most used relations during morning and evening peak hour. Most of the trips have an origin or a destination in Bethlehem, which is explained by the presence of the external PT station at various location as shown in **Map 15**. All Palestinian external zones (the rural areas in Bethlehem Governorate) and Hebron, but also Jerusalem are producing and attracting a large number of PT trips that have the destination or are leaving from Bethlehem area, during both morning and evening peak hour, as shown in **Table 23** below. Since the data regarding internal public transport is scarce, it is difficult to estimate the proportion these external trips represent of the total number of PT trips.

**Table 23.** External public transport trips (person-round trips) per location during morning and evening peak hour

Locality/ area	Morning peak hour		Evening peak hour	
	Generated	Attracted	Generated	Attracted
Beit Jala	11	0	0	9
Bethlehem	1,795	2,215	2,228	1,752
Al Khader	7	0	0	0
Beit Sahur	12	15	0	0
Southern Zone	203	78	253	215
Southeast Zone	503	113	270	560
Eastnorth zone	253	234	129	222
Hebron	492	468	360	483
Jerusalem Munic. Boundary	96	464	315	232
Jericho	9	7	7	5
Ramallah	35	27	34	51
Nablus, Tulkarm, Jenin, Jericho	0	0	0	59
Israel	30	25	66	0
Western Zone	513	313	297	371
<b>TOTAL</b>	<b>3,959</b>	<b>3,959</b>	<b>3,959</b>	<b>3,959</b>

**Map 31.** External and through traffic (public transport) during morning and evening peak





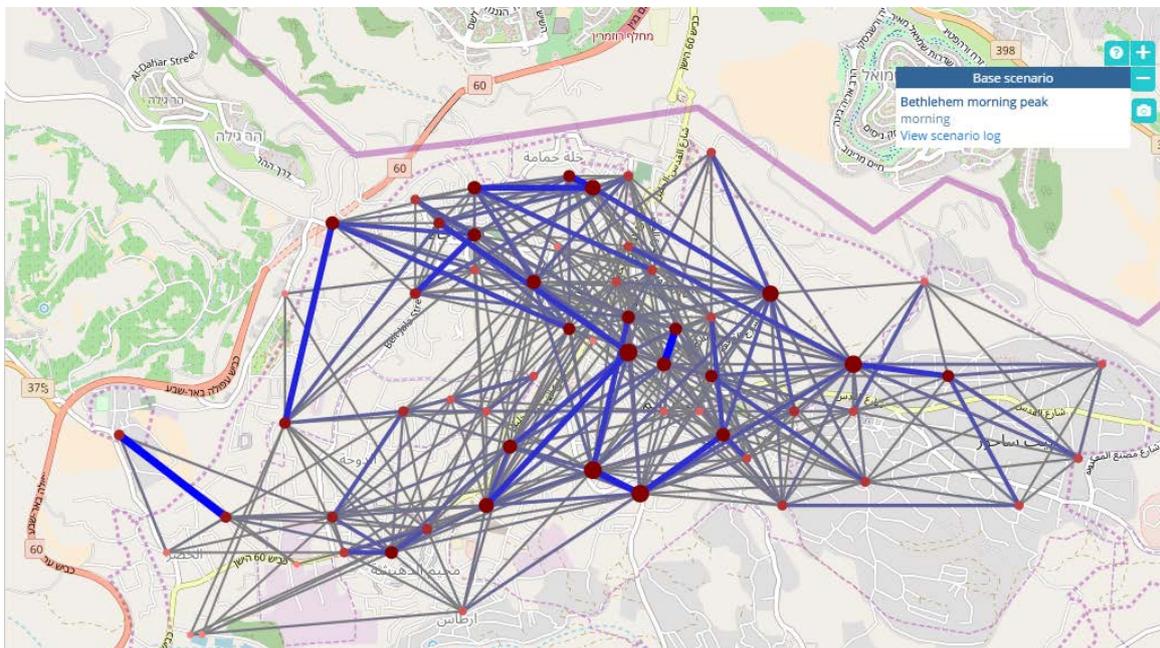
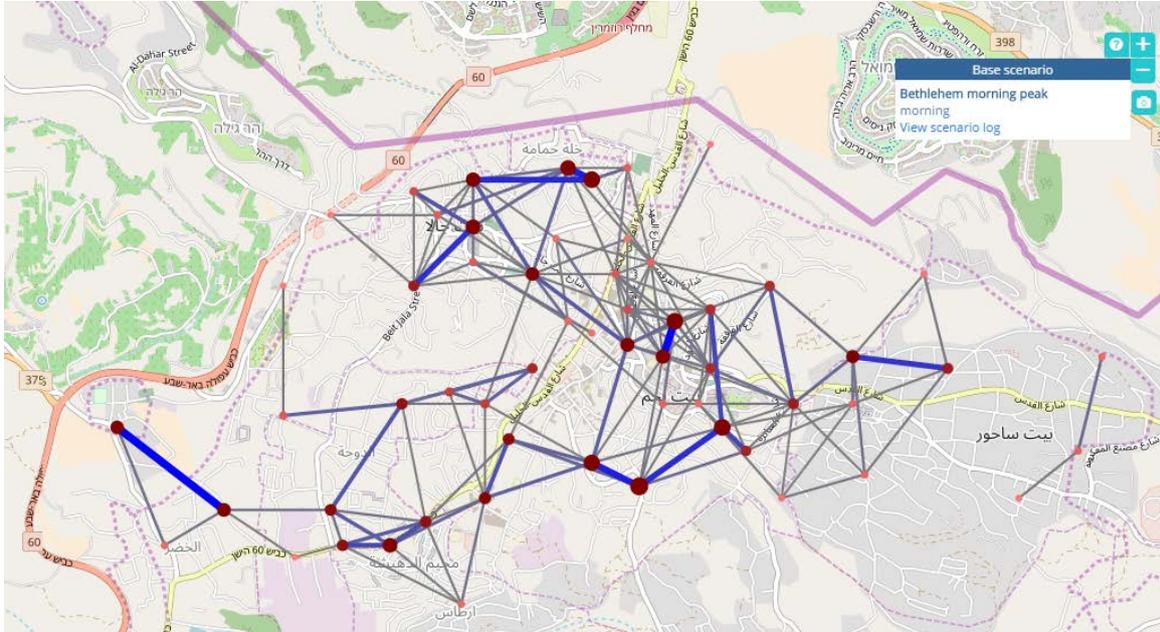
### **Length of trips and kilometres travelled**

Given the short distances within the study area, most of the trips done by private vehicle are short trips (less than 2 kilometres). These trips have a very big potential to shift to walking, if pedestrian infrastructure is to be improved. By analysing the data, it can be concluded that during morning peak hour (on a Thursday), only 5,109 trips are longer than 2 km and 7,581 are longer than 1 km, out of a total of 16,083 internal trips. That means that approximately 52% of the trips in Bethlehem area are shorter than 1 km and 68% are shorter than 2 km in the morning.

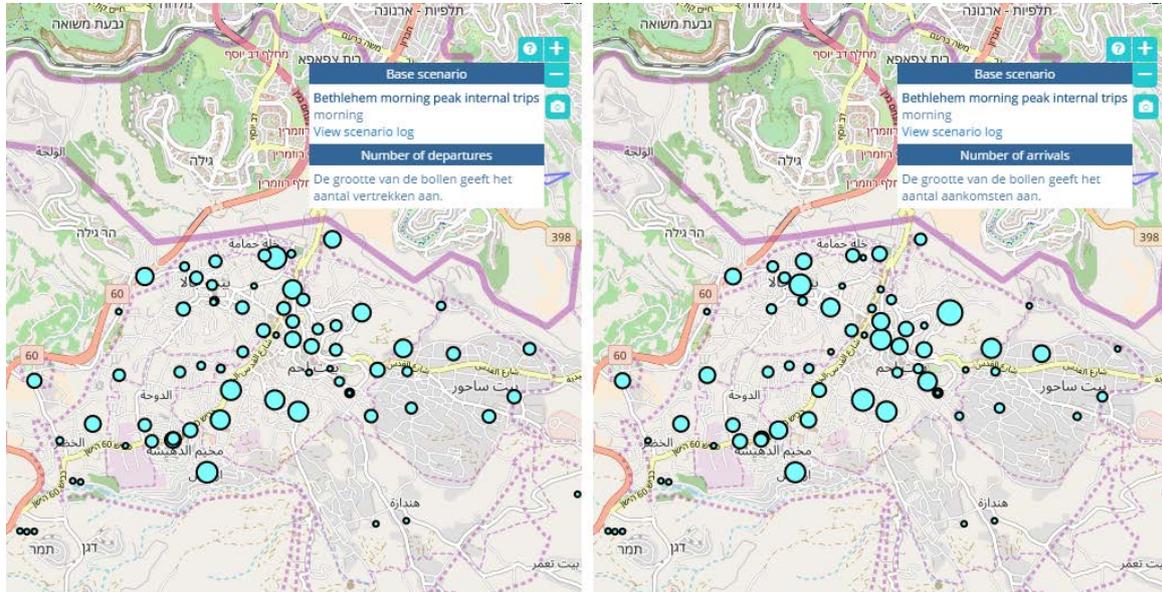
During evening peak hour, 5,749 trips are longer than 1 km and 2,211 are longer than 2 km, out of a total number of 8,721 internal trips (private vehicles). This means that 35% of the trips are shorter than 1 km and no less than 75% are shorter than 2 km. It is important to mention that even with improvements made at the pedestrian infrastructure and education campaigns, only a share of these trips will shift to walking, given climate factors in Bethlehem area, declivity on some streets, cultural and religious believes. Moreover, trips for shopping are many times done by private vehicle due to convenience (carrying of groceries, etc.). All these aspects will be considered in the following stages of the project, while developing and assessing the future scenarios.

The distribution of these trips in terms of location and origin-destination relation can be seen in [Map 32](#) to [Map 35](#).

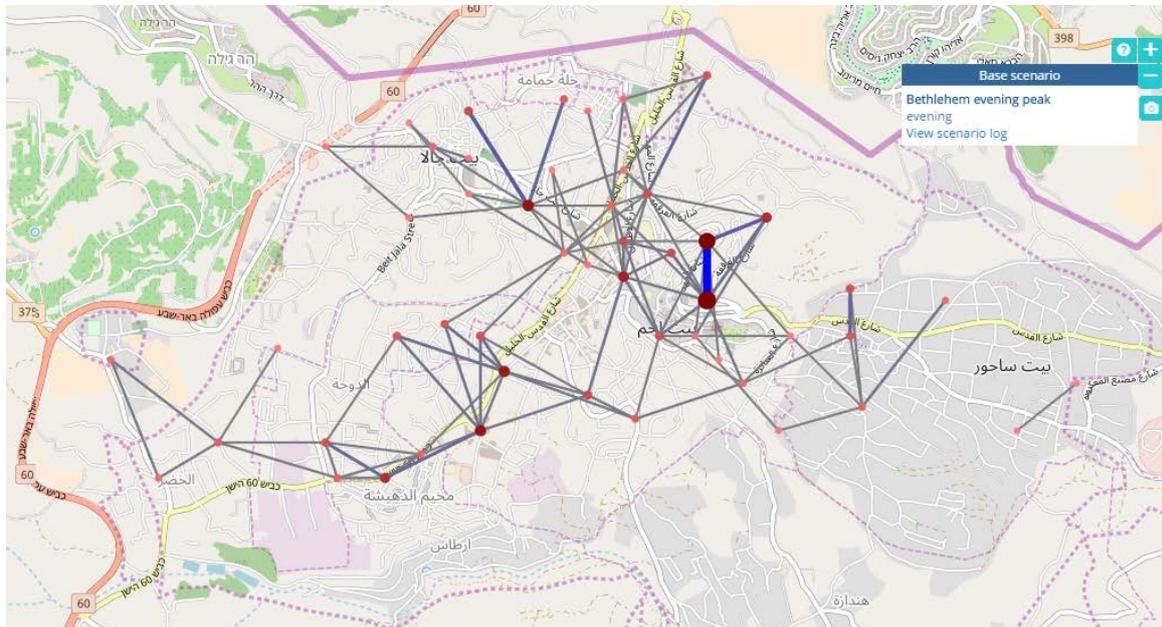
**Map 32.** Distribution and location of trips shorter than 1 km and 2 km during morning peak hour

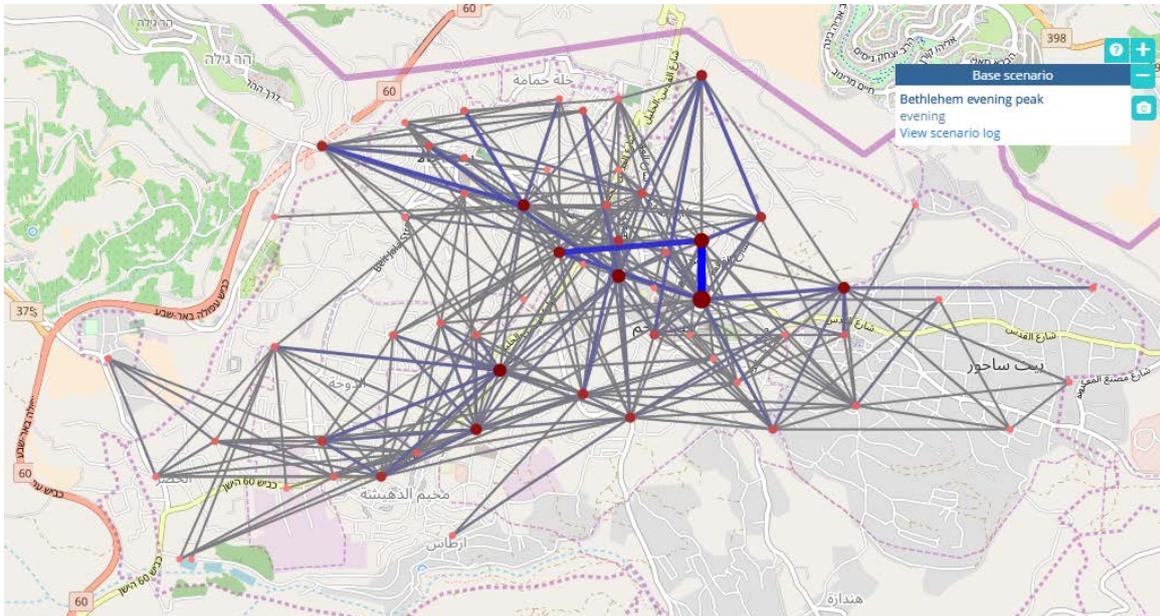


**Map 33.** Location and number of trips (arrivals/ departures) shorter than 2 km during morning peak hour

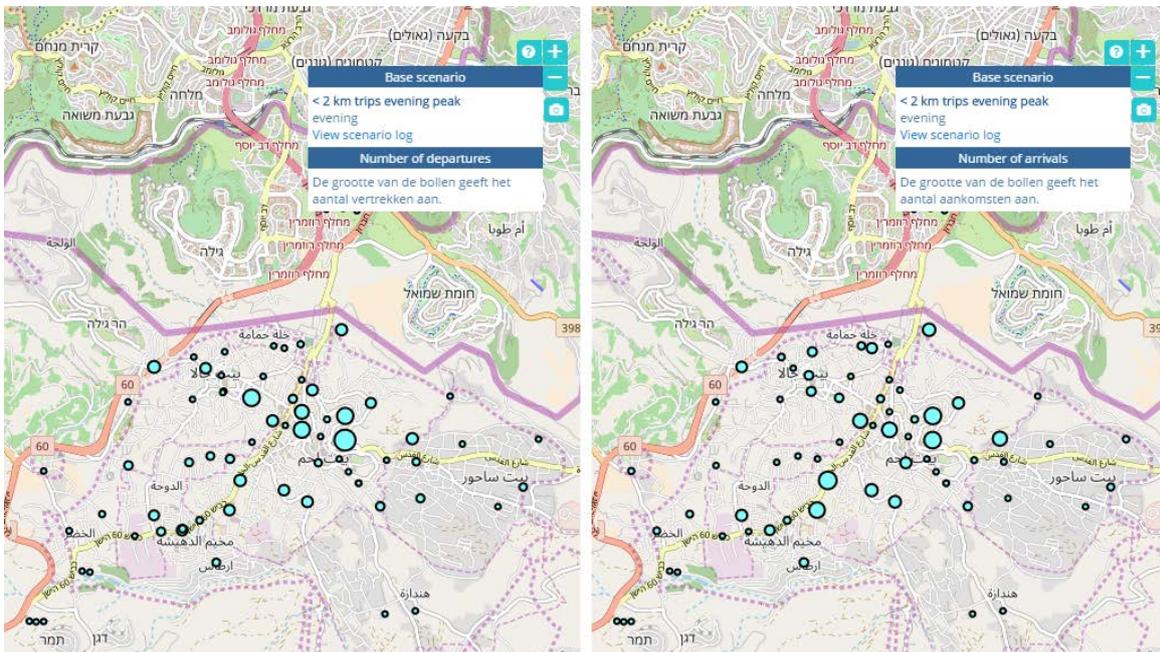


**Map 34.** Distribution and location of trips shorter than 1 km and 2 km during evening peak hour



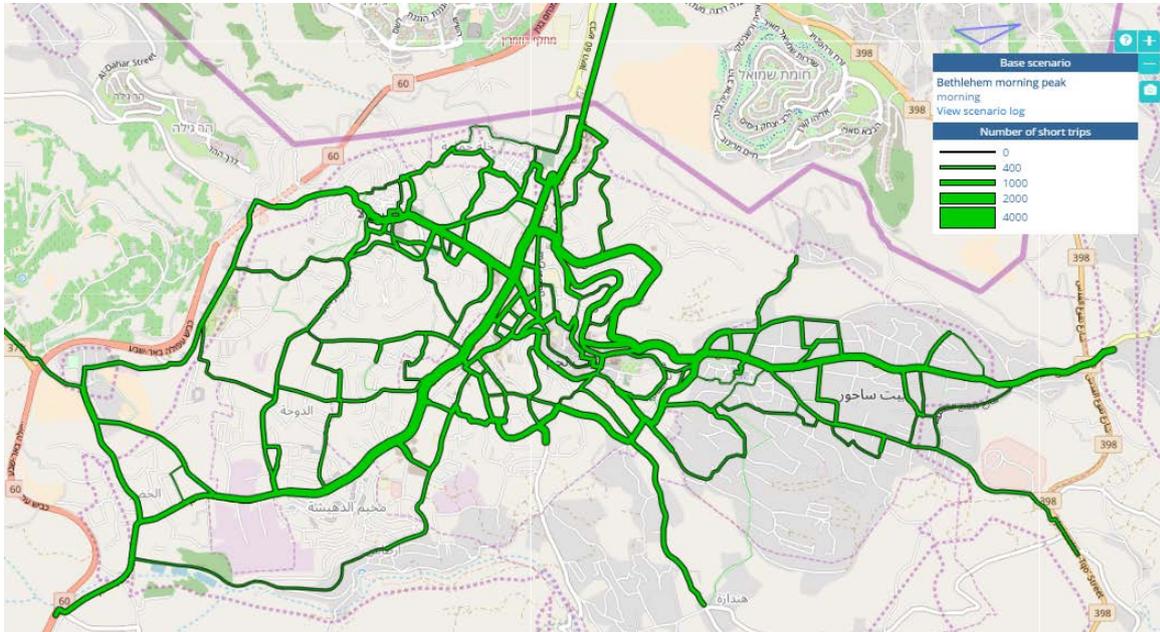


**Map 35.** Location and number of trips (arrivals/ departures) shorter than 2 km during evening peak hour



Overall, more than 90% of the internal trips are shorter than 5 km on all main links of the network, during both morning and evening peak hour.

**Map 36.** Volumes of trips shorter than 5 km on the whole network during morning peak hour



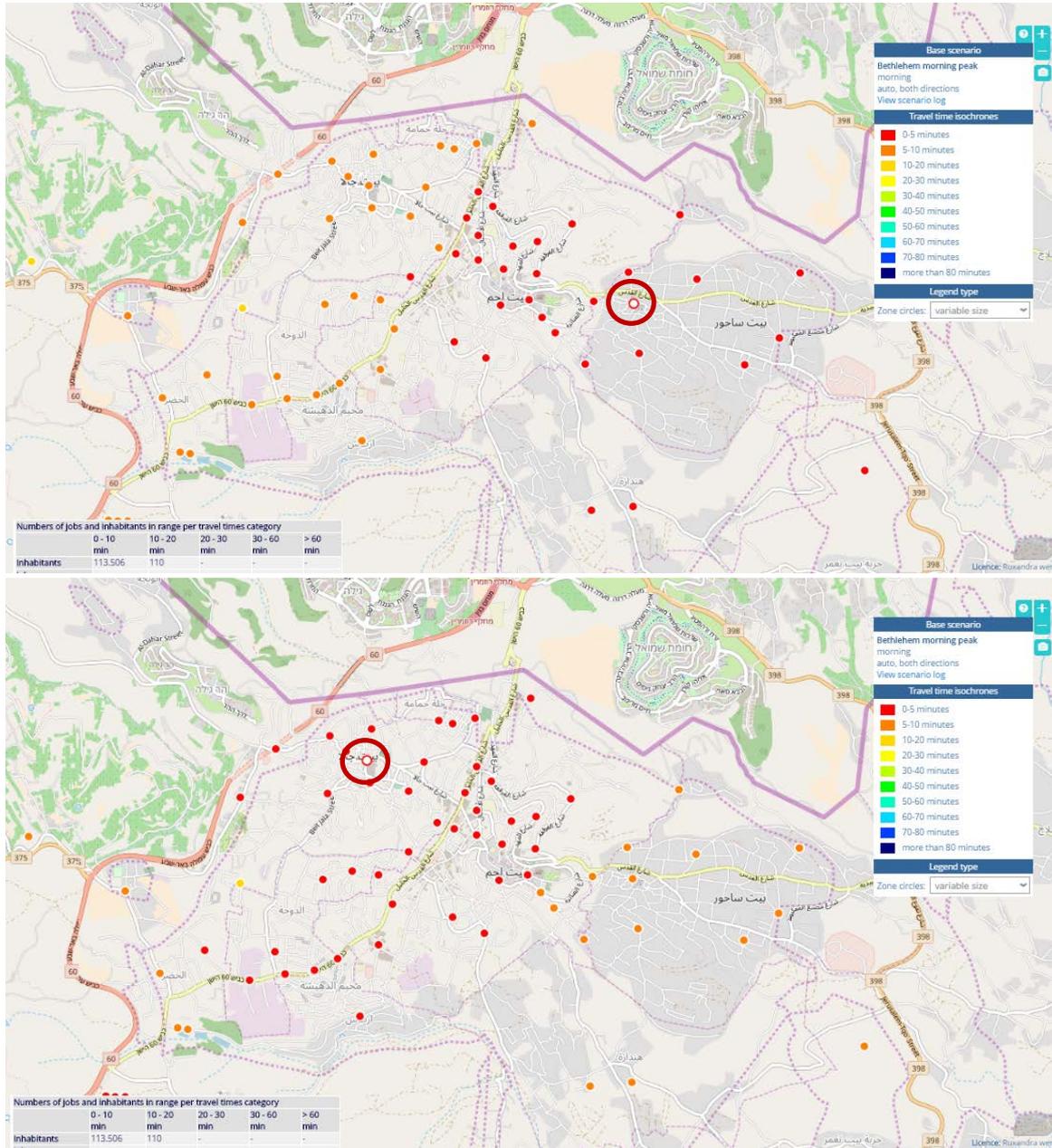
In terms of kilometres travelled, during morning peak hour a total of 28,168 km are travelled internally, within the study area, while 19,368 represents trips shorter than 2 km. During evening peak hour, the total kilometres travelled are 19,650, with 11,178 km accounting for trips shorter than 2 km.

**Accessibility**

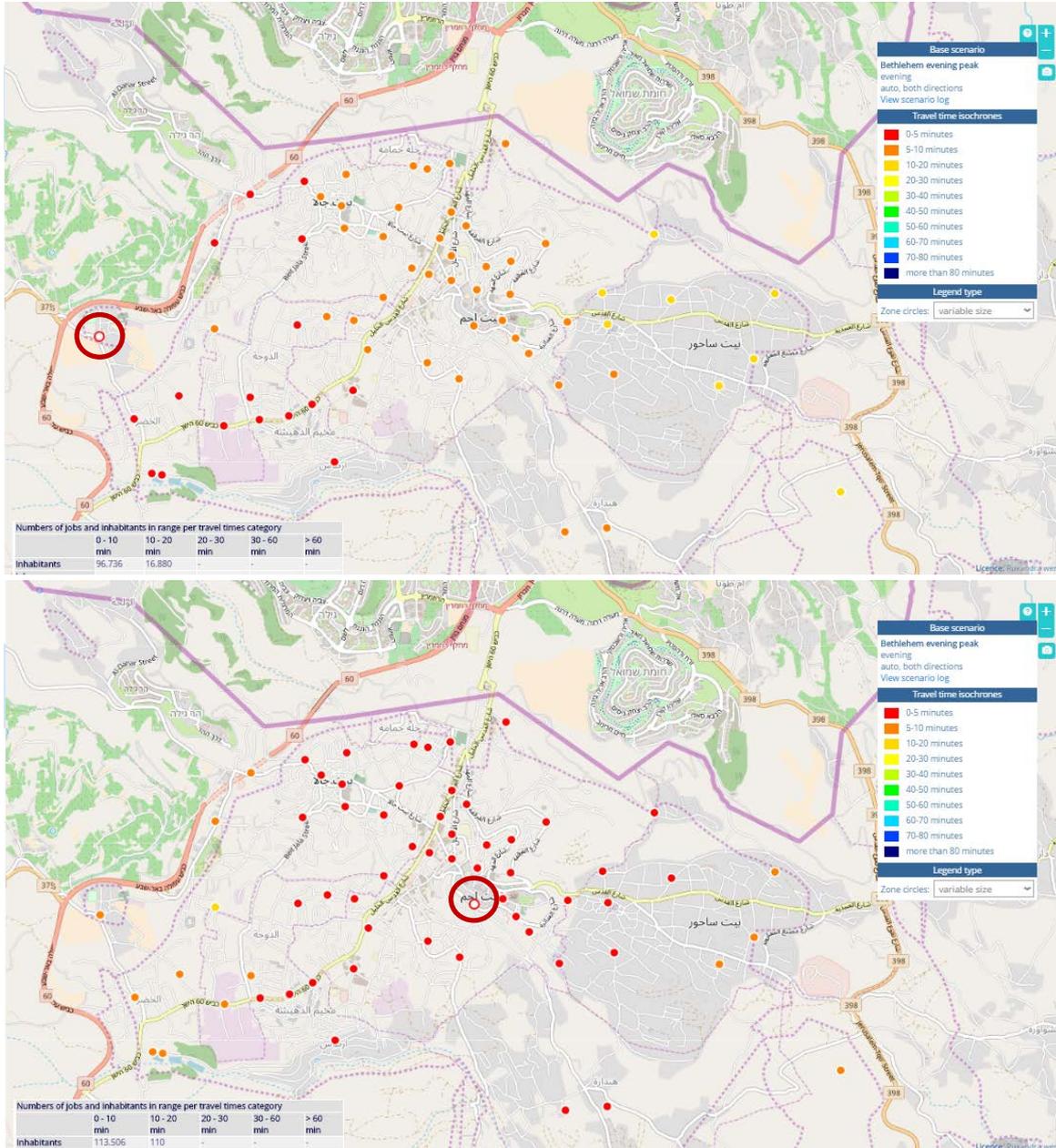
In order to understand the accessibility in Bethlehem, various analysis can be deployed. The following maps show some analysis of the accessibility in the study area, using the model data as input and the MOVE Meter as a tool for analysis.

A common indicator for understanding accessibility is travel time. This can be shown on an isochrone map, a map showing areas related to isochrones between different points. An isochrone is defined as "a line drawn on a map connecting points at which something occurs or arrives at the same time". In transportation planning isochrone maps are commonly used to depict areas of equal travel time. By using this kind of map, it is possible to see immediately the areas (in relation to the selected zone) which are experiencing delays and which zones are accessible or not. In general, by analysing the isochrone maps of Bethlehem conurbation, it can be concluded that all areas are accessible by private vehicle, with most areas been accessible between 5 and 20 minutes.

Map 37. Travel time isochrone private vehicle during morning peak hour



**Map 38.** Travel time isochrone private vehicle during evening peak hour

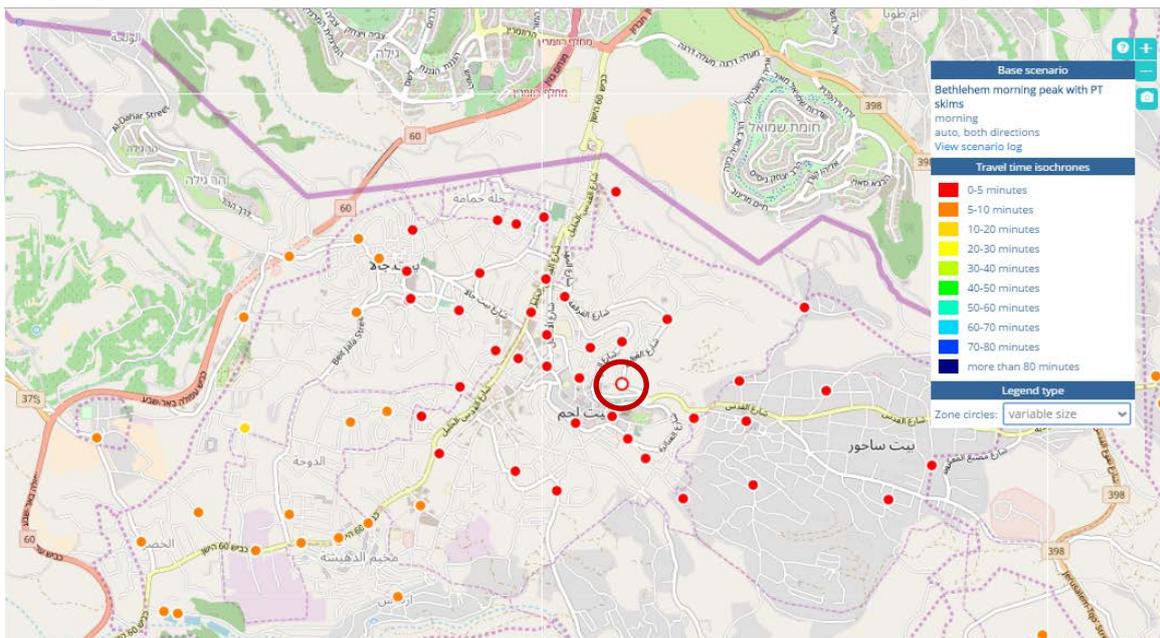
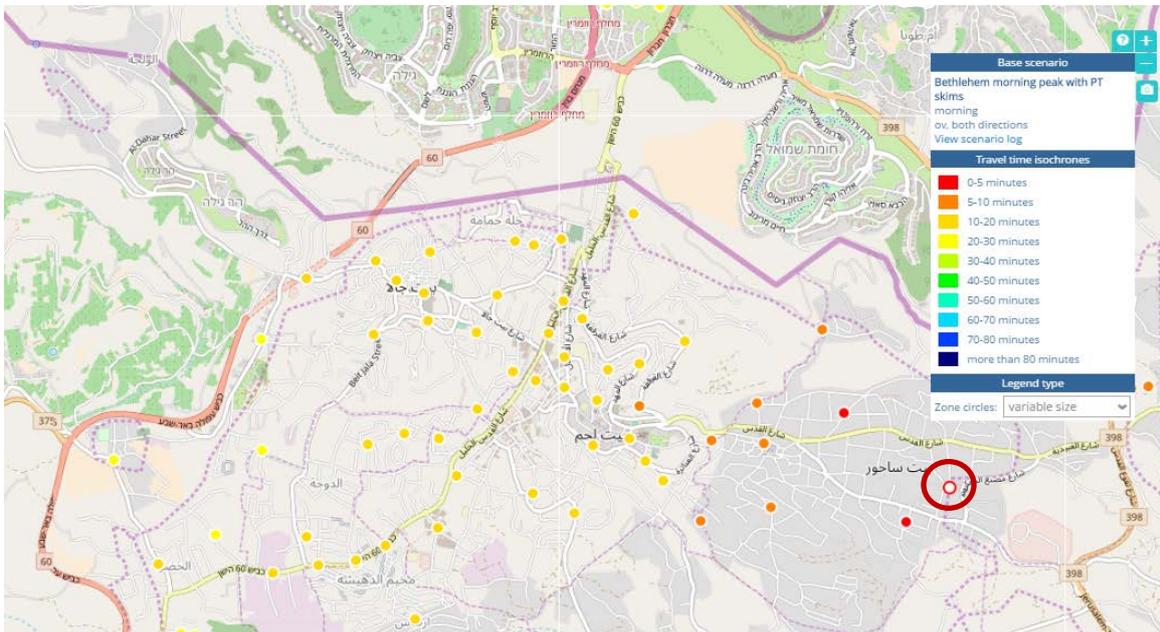


For public transport, the situation is slightly different, given the coverage of PT routes (see [Map 13](#) and [Map 14](#)). The travel time for public transport has been calculated based on distance to nearest route on foot (in the absence of dedicated stations) and the above-mentioned coverage of PT. It should be mentioned that given the fact that buses and shared taxi don't have a set schedule, an estimated waiting time has also been considered. Given all these, PT travel time analysis (isochrone) could not be precisely established, but the maps below show a realistic situation, based on local knowledge, field work and modelling and calculation efforts.

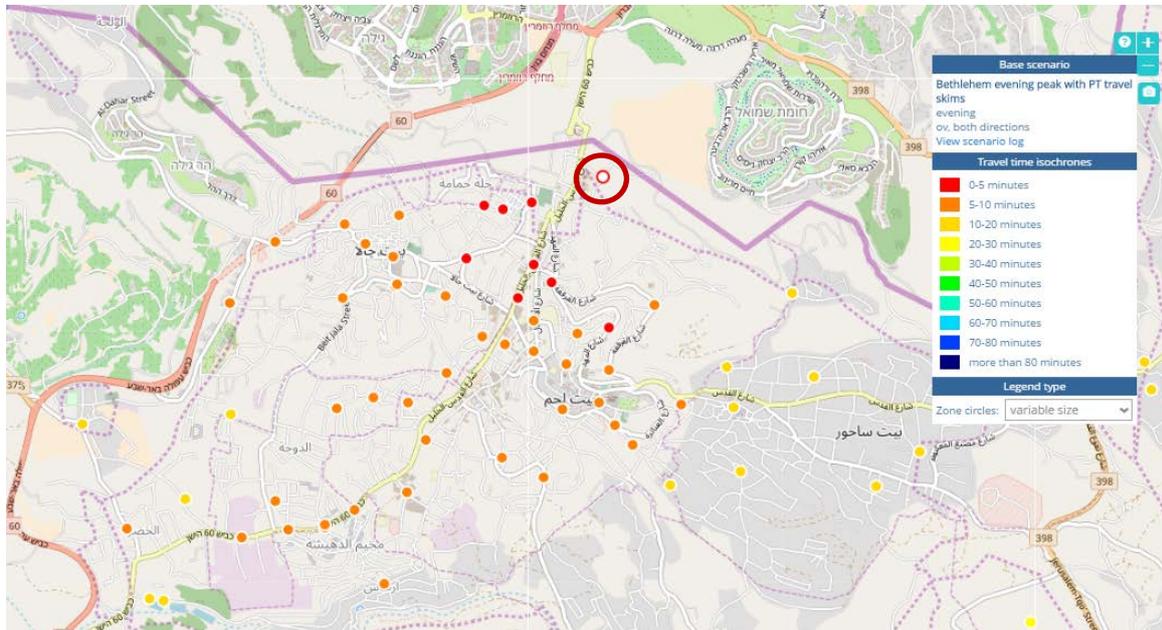
Thus, given the fact that Beit Sahur has no public transport line connecting it to the rest of the area, travel times by PT are much longer than by private vehicle. Reaching the city centre of Bethlehem would take

between 20 and 30 minutes by PT, while by private vehicle it would take 5 to 10 minutes. The situation is different in the city centre of Bethlehem, which is served by various internal public transport lines. Beit Jala seems to be accessible by public transport, but based on local knowledge it has been determined that line 17 reaching the far west end of the municipality is not served by enough vehicles and travel times (due to very long waiting times) are much longer than 5-10 minutes. Situation is comparable during both morning and evening peak hour. In general, for travelling from north to south (or back) the maximum travel time would be 30 minutes, during both morning and evening peak hour. Same goes for trips made by private vehicles, since public transport doesn't have dedicated lanes.

**Map 39. Travel time isochrone by public transport during morning peak hour**

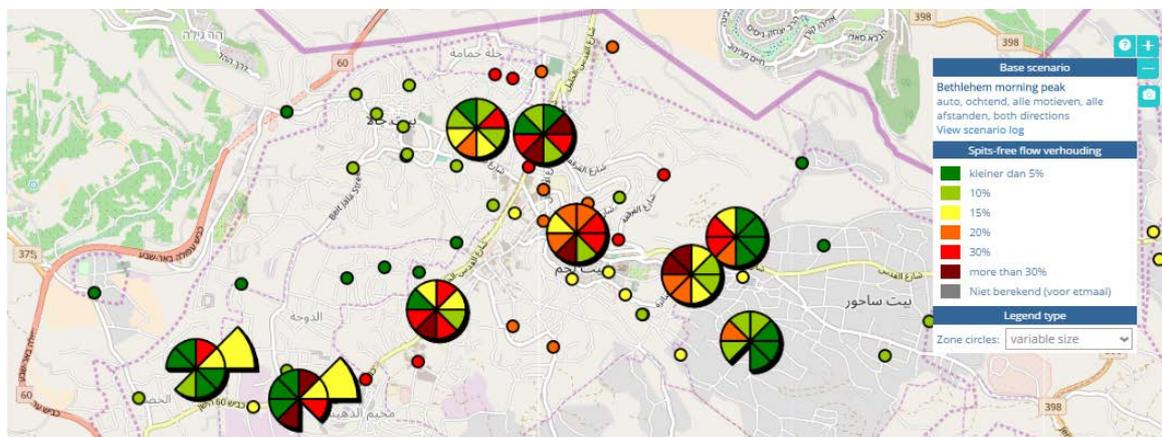


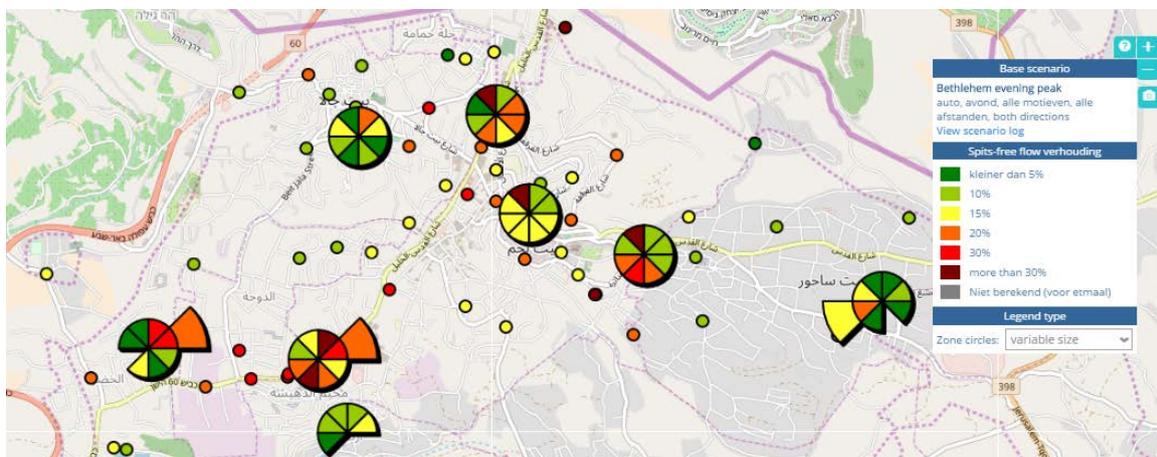
**Map 40.** Travel time isochrone by public transport during evening peak hour



Accessibility of various zones can also be assessed by using the so called “dart diagrams” for peak/ free-flow ratio. The maps below show the situation in Bethlehem and make it possible to understand the corridors and directions where traffic problems occur and trips are delayed in peak hour conditions, as compared to non-peak. The dark red indicates the direction from which the trips done during peak hour need longer time to arrive to their destination than during off-peak. The percentages mean that, for trips with a 15% mark for example, the trips have 15% longer travel times during peak hour than in the off-peak period. The green colour shows that the zones are highly accessible and trips experience no delays in peak hour conditions. The corridor north-south presents the most acute problems (Hebron – Jerusalem Road), together with the city centre of Bethlehem and the relation Beit Sahur and Bethlehem. This gives an indication of areas where interventions are needed in the near future.

**Map 41.** Dart diagram of peak/ free-flow ration during morning and evening peak hour





### Conclusions

Understanding the travel patterns and the problematic areas within Bethlehem conurbation is an important step for defining the baseline against which future scenarios can be measured and assessed. What can be stressed is that modal choice has a great variation across municipalities, but also in terms of journey purpose. In general, non-work and non-school related trips are mostly done by private vehicle (leisure, visiting friend and family), despite the short distances. This is mostly related to the poor quality of pedestrian infrastructure, as described above, but also to cultural and education aspects.

In general, Bethlehem conurbation is not suffering from severe and structural congestion, with streets having still enough capacity to accommodate traffic. Also travelling speeds are not severely reduced except for punctual locations due to configuration of intersections and roundabouts or incidental congestion (such as the bottleneck next to schools or in front of hotels). This is valid for the 2017 baseline scenario (current situation), but if population and car ownership continue to grow at current rates, situation will change in the following decades.

In terms of external, internal and through traffic, contrary to expectations Bethlehem is not suffering from through traffic (trips that have neither origin or destination in Bethlehem), with very low shares – 1% during morning peak hour and 6% during evening peak hour. Situation is slightly different regarding external traffic (trips with either origin or destination in Bethlehem). Thus, external trips represent 14% during morning peak hour and 33% during evening peak hour. Public transport accounts for a large share of external trips, as well.

All the information obtained from the data collection and processing (modelling), together with the qualitative analysis of the transport system will form the baseline against which future scenarios will be measured and assess.

### 3.12 Urban development and economic potential of the area; Urban accelerators

As stated above, in section 3.1, all municipalities that are within the study area have various on-going urban development plans and their main objectives are to increase the economic potential of the area and ultimately increase the quality of life for their inhabitants.

Considering the historical heritage that it has, the multiple hotels and restaurant amenities, the number of young and educated people, Bethlehem certainly has a great urban and economic development potential. Tapping into this potential is important and understanding how urban/ economic transformation is linked with mobility and transport in the area is a key element for a balanced, smart and sustainable growth. This should be based on a strategy that takes into account specific locations (so called urban accelerators) and their impact on mobility, transport, economy and quality of life.

Urban accelerators or urban acupuncture are defined as small-scale interventions that are able to transform the larger urban context. This theory advocates for an alternative to massive urban renewal projects in favour of a more localised and community-based approach in an era of constrained budgets and limited resources.<sup>44</sup> Implementing urban acupuncture projects as part of a comprehensive and strategic plan can become a pro-active steering tool for decision makers to create tangible measures leading to actual improvements in the urban domain which are more realistic, effective and give a maximum impact to the surrounding<sup>45</sup>. These can be from a mass transport system such as a BRT (e.g. Curitiba BRT line) to a museum (e.g. Guggenheim Museum in Bilbao).

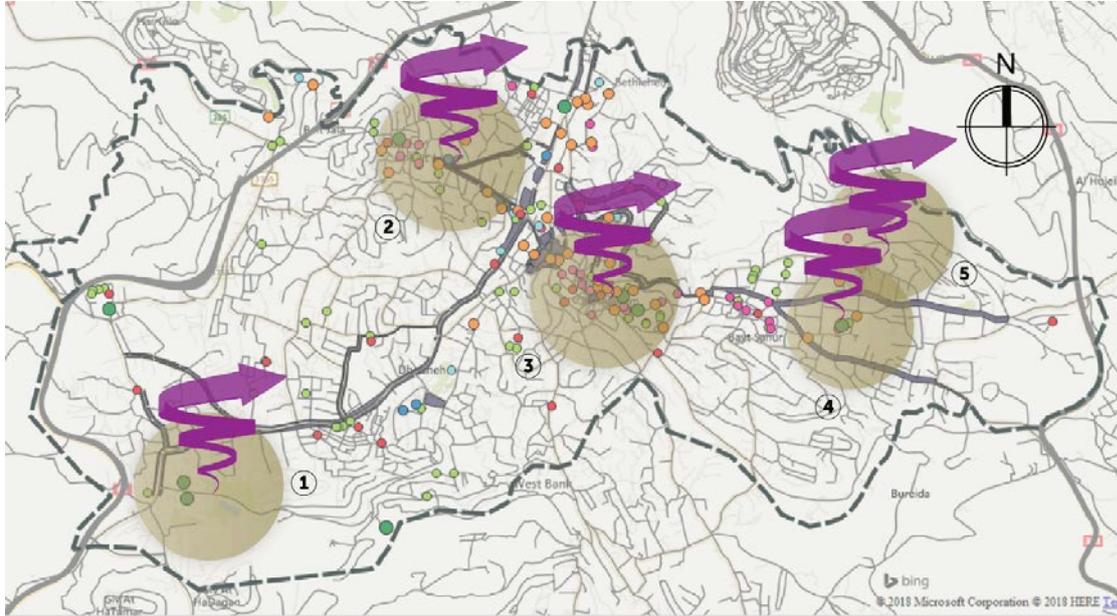
Bethlehem has various such locations (*Map 42*) that have the potential to accelerate the economic growth and support a vibrant life. These locations should also be supported by a sound transport and mobility strategy, in order to become accelerators.

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<sup>44</sup> Jaime Lerner, *Urban Acupuncture: Celebrating Pinpricks of Change that Enrich City Life*, (Washington, DC: Island Press, 2014)

<sup>45</sup> MOVE Mobility, *Urban Accelerator Bellville: Workshop report*, (2017), Unpublished internal document.

**Map 42.** Urban accelerators in Bethlehem area



- ① Solomon's Pools
- ② Beit Jala old city centre, S. Nicolas Church and Al Al Sahel commercial street
- ③ Bethlehem old city centre, Nativity Church and Milk Grotto
- ④ Orthodox Field of Shephards
- ⑤ Shephards's Fields

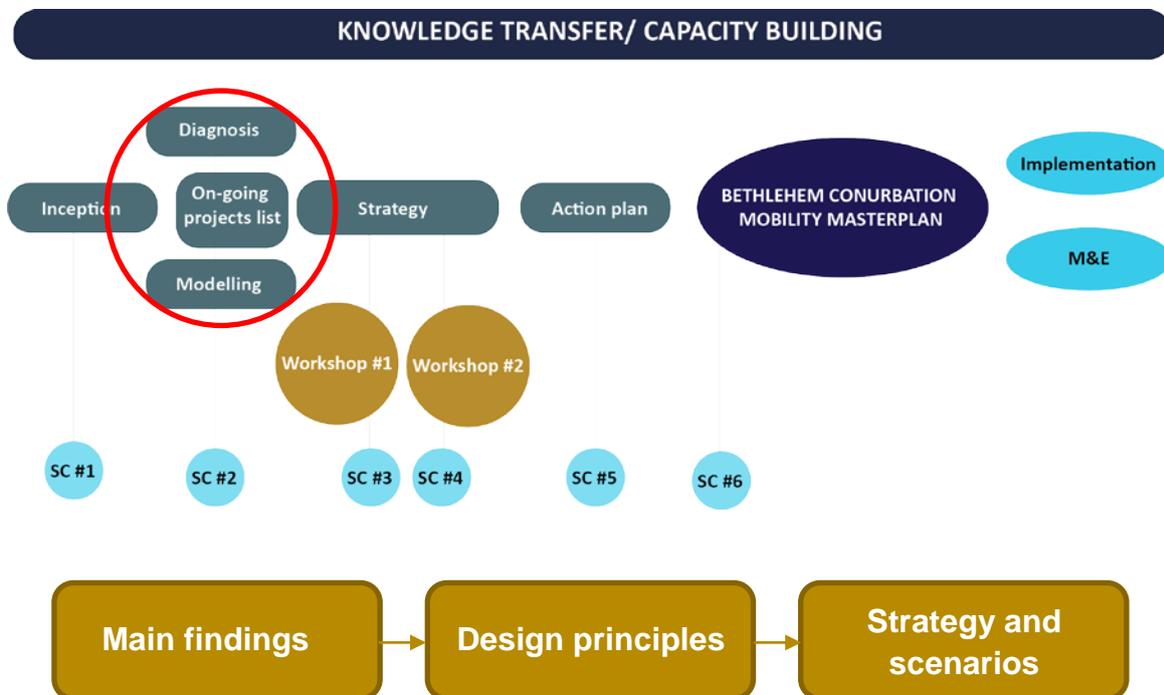
### Conclusions

In terms of urban development, it is crucial to find a balance between growth accessibility and liveability. The so-called accelerators are already functioning as accelerators for both urban and economic growth, but they can also pose challenges in terms of mobility and accessibility. Careful consideration should be given to these sensitive points for future scenarios.

#### 4. CONCLUSIONS AND FURTHER STEPS

This report represents the final output of Phase 1: Diagnosis and analysis. The purpose of this report has been to assess the current situation related to mobility in Bethlehem area, for 2017 baseline year. The report presents an overall assessment, focusing on challenges that will be tackled and opportunities that need to be tapped into in the further steps of the project (strategy development, scenario development, which will be supported by co-creation and interactive workshops – see *Figure 20*). The topics discussed are: legislative, institutional and regulatory framework, socio-economic data and trends, urban form and structure, regional position, climate change and environment, road network, public transport, non-motorised transport, parking, road safety, mobility patterns and accessibility and urban accelerators. For all these topics, the main challenges have been identified.

*Figure 20. The project timeline and logical structure*



Our main (summarised) findings related the dysfunctionalities in the study area, related to the topics mentioned above, are as follows:

» *Legislative and institutional framework*

Challenges	Opportunities
<ul style="list-style-type: none"> <li>• Fragmented and outdated legislation, fragmented responsibilities</li> <li>• Lack of enforcement</li> <li>• Israeli control and expansion</li> <li>• Insufficient budget</li> <li>• The absence of the private sector</li> <li>• Low institutional and financial capacity at municipalities</li> <li>• Overall lack of unitary vision for transport</li> <li>• Poor cooperation between stakeholders</li> </ul>	<ul style="list-style-type: none"> <li>• Political will for change</li> <li>• International financial support and know-how</li> <li>• Strong decision power for municipalities</li> <li>• Already existing institutions in place: the Transport Committee</li> </ul>

» *Socio-economic data*

Challenges	Opportunities
<ul style="list-style-type: none"> <li>• Unstable and volatile economic development</li> <li>• High levels of unemployment</li> <li>• Israeli control and occupation</li> <li>• Growing car ownership rates</li> <li>• Old and depleted vehicle fleet</li> </ul>	<ul style="list-style-type: none"> <li>• Very young (active) population</li> <li>• Economic development starting to stabilise and grow</li> <li>• Tourism levels growing</li> </ul>

» *Urban form and structure*

Challenges	Opportunities
<ul style="list-style-type: none"> <li>• High (excessive) population density in some areas (camps)</li> <li>• Limited (inexistent) space for growth</li> <li>• Lack of natural areas for leisure, sports, recreation</li> </ul>	<ul style="list-style-type: none"> <li>• High concentration of amenities, facilities along main roads and in the city centres – short distances</li> <li>• Some areas reserved for future development</li> </ul>

» *Regional position*

Challenges	Opportunities
<ul style="list-style-type: none"> <li>• Through traffic connecting north and south, east and west</li> </ul>	<ul style="list-style-type: none"> <li>• Strategic regional position – economic corridor</li> <li>• Good connectivity with areas in and outside the governorate</li> </ul>

» *Climate change and environment*

Challenges	Opportunities
<ul style="list-style-type: none"> <li>• Extreme weather events already present</li> <li>• Low quality and old vehicle fleet – high emissions</li> <li>• High concentrations of pollutants</li> <li>• Difficult to find a balance between development and climate/ environmental protection requirements</li> </ul>	<ul style="list-style-type: none"> <li>• Political will to tackle climate change</li> <li>• Paris Agreement signed</li> <li>• Transport recognised as a major potential change for reducing climate change</li> <li>• Policies and regulations encouraging the acquisition of new vehicles</li> </ul>

» *Road network*

Challenges	Opportunities
<ul style="list-style-type: none"> <li>• No road categorisation</li> <li>• Uneven distribution – high capacity roads discharging in city streets</li> <li>• Bottlenecks and disruptions</li> <li>• Improper use of roads</li> <li>• Illegal parking</li> <li>• No road marking and signalling</li> <li>• Poor quality of surfaces</li> <li>• Lack of enforcement</li> </ul>	<ul style="list-style-type: none"> <li>• Political will to improve road network</li> <li>• Dense network</li> <li>• Many options for driving</li> <li>• Main roads with a wide profile – space for redesign and improvement</li> <li>• No structural or systemic congestion</li> </ul>

» *Public transport*

Challenges	Opportunities
<ul style="list-style-type: none"> <li>• Unregulated system – semi-informal</li> <li>• Unreliability due to lack of schedules and stops</li> <li>• Unsafe boarding and unboarding</li> <li>• Insufficient coverage within reasonable walking distance (in some areas)</li> <li>• Travel time loss due to waiting time at stations</li> <li>• Incompetitive prices due to low price of gasoline (for private vehicles)</li> </ul>	<ul style="list-style-type: none"> <li>• High share of use – 35%</li> <li>• Previous studies for PT at regional, national level (ORIO project*)</li> <li>• High coverage within Bethlehem city centre</li> </ul>

\*Note: ORIO project (<https://www.rvo.nl/subsidies-regelingen/projecten/improving-public-transport-infrastructure>) is a project funded by RVO – Rijksdienst voor Ondernemend Nederland (the executive agency of the Dutch Ministry of Economics and Climate). The project is defined as the development, construction, equipping, training and subsequent use and maintenance of public bus infrastructure in the West Bank. The main aim is to provide an integrated solution to improve passenger bus services in the West Bank by combining necessary investments in new buses and associated bus facilities with parallel institutional reform implemented by the Ministry of Transport (MoT) to support the long-term financial sustainability of the sector. In doing so, the project will benefit the economic and social functioning of the West Bank. The project started in 2013 and is still on-going.

» *Non-motorised transport*

Challenges	Opportunities
<ul style="list-style-type: none"> <li>• Very low share of use – 9%</li> <li>• Lack of proper walking infrastructure</li> <li>• Low quality of walking facilities and urban space – parked cars, shops merchandise, construction debris occupying pavement</li> <li>• Lack of urban furniture and greenery</li> <li>• Lack of continuity of pavement</li> <li>• Extreme weather in some seasons</li> <li>• Priority given to cars</li> <li>• Lack of marking and signalling for pedestrians</li> </ul>	<ul style="list-style-type: none"> <li>• Political will to make the area attractive for pedestrians</li> <li>• Short distances and many amenities within walking distances</li> <li>• Multitude of touristic attractions, commercial and restaurants areas</li> <li>• Well lit areas during the evening/ night</li> <li>• Wide enough streets in many locations to accommodate proper pavement</li> <li>• Many short trips made by car that can shift to walking</li> </ul>

» *Parking*

Challenges	Opportunities
<ul style="list-style-type: none"> <li>• Low enforcement – illegal parking</li> <li>• Low parking fees</li> <li>• No differentiated paid system per zone</li> <li>• Lack of a parking area for touristic buses</li> <li>• Reduced capacity of streets due to legal and illegal parking</li> <li>• Municipality has almost no revenue from parking</li> </ul>	<ul style="list-style-type: none"> <li>• Municipality can collect parking fees</li> <li>• High concentration of amenities</li> <li>• Short distances</li> <li>• Some space available for parking areas</li> <li>• High parking demand in some areas</li> </ul>

» *Road safety*

Challenges	Opportunities
<ul style="list-style-type: none"> <li>• Increasing number of accidents and deaths</li> <li>• Lack of sufficient police officers</li> <li>• Lack of enforcement</li> <li>• High number of illegal vehicles</li> <li>• Poor driving behaviour</li> <li>• No markings and signalling for vehicles, pedestrians</li> <li>• No authority over cars coming from Israel</li> <li>• No space for depositing detained vehicles</li> </ul>	<ul style="list-style-type: none"> <li>• There is a Road Safety Manual</li> <li>• New regulation approved for traffic violation</li> <li>• There is political and institutional will to improve safety</li> <li>• Population is young and can participate in school education campaigns</li> </ul>

» *Mobility patterns and accessibility*

Challenges	Opportunities
<ul style="list-style-type: none"> <li>• Some corridors (north-south) experiencing delays</li> <li>• Very low share of walking especially for leisure, shopping, visiting friends/ family</li> <li>• Bottlenecks in some location</li> </ul>	<ul style="list-style-type: none"> <li>• No structural congestion</li> <li>• High share of trips shorter than 2 km</li> <li>• High accessibility by both car and PT for many places</li> </ul>

These findings will form the base for the further analysis and for developing the vision, strategy and scenarios, together with the stakeholders involved. For addressing each topic, we will apply guiding/ design principles to transform Bethlehem conurbation transport system into a sustainable, efficient and inclusive one.

The next step in the project is to draw a general vision for the future of mobility in Bethlehem and to develop scenarios. The process will start with a participatory Stakeholders' Workshop, on the 18<sup>th</sup> and the 19<sup>th</sup> of September in Bethlehem. The workshop will gather together actors from various organisation, representatives of public institutions for local, regional and national level, representatives of businesses and of the civil society. The workshop will focus on good practices for urban transport planning and the development of the scenarios through a participatory and co-creative process. The agenda for the two days is as follows:

<i>Tuesday, 18 September</i>		<i>Wednesday, 19 September</i>	
8:30-9:00	<b>Registration</b>	8:30-9:00	<b>Registration</b>
9:00-9:15	<b>Opening ceremony by Bethlehem Municipality</b>	9:00-9:15	<b>Plenary session 1</b> – opening and summary of the previous day
9:15 – 9:30	<b>Plenary session 1</b> – The project so far (previous and next steps)	9:30 – 11:30	<b>6 Breakout sessions</b> (cont.)
9:30 – 10:30	<b>Plenary Session 2</b> – International experiences in sustainable mobility	11:30 – 12:00	<b>Coffee/ Tea break</b>
10:30 – 12:30	<b>6 Breakout sessions</b>	12:00 – 13:30	<b>Plenary session 2</b> – posters presentations and concluding remarks
12:30 – 13:30	<b>Lunch break</b>	13:30 – 14:00	<b>Closing ceremony</b>
13:30 – 14:30	<b>6 Breakout sessions</b> (cont.)	14:00 – 15:00	<b>Lunch and social gathering</b>
14:30 – 15:00	<b>Coffee/ Tea break</b>		
15:00 – 16:00	<b>Plenary session 3</b> – wrap-up, results and discussions		

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\*\*\*Note: All photos belong to the authors of the report, except for: 1b, 2, 4c, 4d, 8a and 12a which are taken from Google Maps Street View.



***PHASE 1: DIAGNOSIS AND ANALYSIS  
INTERMEDIARY REPORT***

**MOBILITY STUDY – PHASE II \ TRANSPORT AND  
MOBILITY STRATEGY FOR THE CONURBATION OF  
BETHLEHEM**

