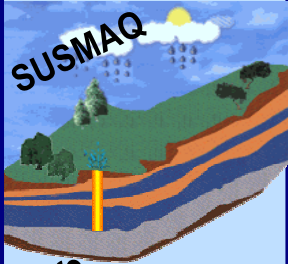




Palestinian National Authority
Palestinian Water Authority



السلطة الوطنية الفلسطينية
سلطة المياه الفلسطينية



West Bank Aquifers-Distribution of Empirical Estimates of Groundwater Recharge by Month

Sustainable Management of the West Bank and Gaza Aquifers

UNIVERSITY OF
NEWCASTLE

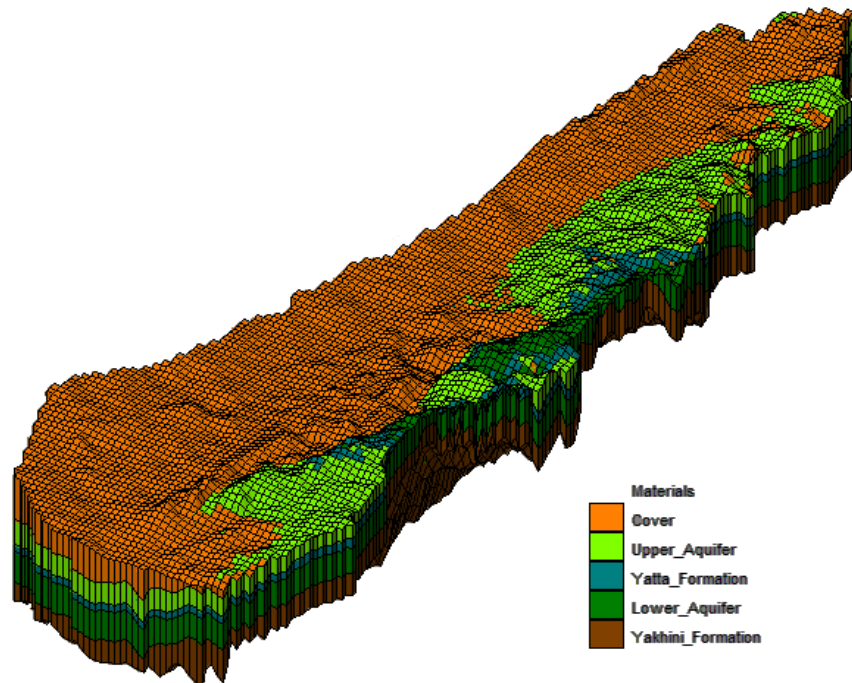


NERC British
Geological Survey



Department for
International
Development

DFID



Working Report
SUSMAQ-REC # 20 V 0.1

Prepared by:

SUSMAQ TEAM

Palestinian Water Authority, Palestine
Groundwater Systems and Water Quality Programme
British Geological Survey, UK

June 2003

| | |
|--|---|
| <p>Disclaimer</p> <p>This working report is an output from the Recharge Estimation Component, part of SUSMAQ project.</p> <p>Working reports are designed to present and to communicate the results of work on the SUSMAQ Project without delay. The findings, interpretations and conclusions expressed are those of the authors (the team) and should not be attributed to other collaborators on the SUSMAQ project.</p> <p>The project does not guarantee the accuracy of the data included in this publication. Boundaries, colours, denominations and other information shown in maps, figures, tables and the text does not imply any judgment on legal status of territory or the endorsement of boundaries. The typescript of this report has not been prepared in accordance with procedures appropriate to formal printed texts, and the partners and funding agency accept no responsibility for errors.</p> | <p>Contact Details</p> <p>Professor Enda O’Connell Project Director University of Newcastle upon Tyne Tel: 0191 222 6405 Fax: 0191 222 6669 Email: P.E.O’Connell@ncl.ac.uk</p> <p>Eng. Fadle Kawash Deputy Chairman Palestinian Water Authority Ramallah, Palestine Tel:02 295 9022 Fax 02 2981341 Email: fkawash@pwa-pna.org</p> <p>Dr. Amjad Aliewi Operations and Technical Manager Team Leader, Hydrogeology and Flow Modelling SUSMAQ Project Office Sunrise Building Al-Irsal Road Al-Bireh/Ramallah, Palestine Tel.02 298 89 40 Fax. 02 298 89 41 e-mail: a.s.aliewi@susmaq.org</p> |
| <p>The SUSMAQ Project</p> <p>The aim of the project is to increase understanding of the sustainable yield of the West Bank and Gaza aquifers under a range of future economic, demographic and land use scenarios, and evaluate alternative groundwater management options. The project is interdisciplinary, bringing together hydrogeologists and groundwater modellers with economists and policy experts. In this way, hydrogeological understanding can inform, and be informed by, insights from the social sciences. The results of the study will provide support to decision-making at all levels in relation to the sustainable yield of the West Bank and Gaza aquifers.</p> <p>The project runs from November 1999 to October 2004, and is a partnership between the Palestinian Water Authority, University of Newcastle and the British Geological Survey. The project is funded by the United Kingdom’s Department for International Development (DFID).</p> | <p>Recharge Estimation Component is part of the SUSMAQ project which aims at developing improved estimates of groundwater recharge to the West Bank Aquifers with emphasis on the Western Aquifer Basin. This will be achieved through developing object oriented model for recharge and studying the hydrochemistry of the aquifers.</p> |
| <p>Bibliographical Reference</p> <p>This report should be referenced as: SUSMAQ (2003). West Bank Aquifers Distribution of Empirical Estimates of Groundwater Recharge by Month. Working report No.: SUSMAQ-REC #20V0.1 Sustainable Management for the West Bank and Gaza Aquifers, Palestinian Water Authority (Palestine) and University of Newcastle upon Tyne (UK).</p> <p>Author:</p> <p>McKenzie AA, British Geological Survey</p> | <p>Feedback</p> <p>This is Version 0.1of the Report, “West Bank Aquifers-Distribution of Empirical Estimates of Groundwater Recharge by Month”. The Recharge Estimation Team welcomes feedback, both positive and negative! Please, tell us what you think about the ideas and issues raised in this report by contacting the team at one of the addresses above. Your feedback will be appreciated and is necessary for updating and correcting this report in another version.</p> |

BRITISH GEOLOGICAL SURVEY

The full range of Survey publications is available from the BGS Sales Desks at Nottingham and Edinburgh; see contact details below or shop online at www.thebgs.co.uk

The London Information Office maintains a reference collection of BGS publications including maps for consultation.

The Survey publishes an annual catalogue of its maps and other publications; this catalogue is available from any of the BGS Sales Desks.

The British Geological Survey carries out the geological survey of Great Britain and Northern Ireland (the latter as an agency service for the government of Northern Ireland), and of the surrounding continental shelf, as well as its basic research projects. It also undertakes programmes of British technical aid in geology in developing countries as arranged by the Department for International Development and other agencies.

The British Geological Survey is a component body of the Natural Environment Research Council.

Keyworth, Nottingham NG12 5GG

☎ 0115-936 3241 Fax 0115-936 3488

e-mail: sales@bgs.ac.uk

www.bgs.ac.uk

Shop online at: www.thebgs.co.uk

Murchison House, West Mains Road, Edinburgh EH9 3LA

☎ 0131-667 1000 Fax 0131-668 2683

e-mail: scotsales@bgs.ac.uk

London Information Office at the Natural History Museum (Earth Galleries), Exhibition Road, South Kensington, London SW7 2DE

☎ 020-7589 4090 Fax 020-7584 8270

☎ 020-7942 5344/45 email: bgs london@bgs.ac.uk

Forde House, Park Five Business Centre, Harrier Way, Sowton, Exeter, Devon EX2 7HU

☎ 01392-445271 Fax 01392-445371

Geological Survey of Northern Ireland, 20 College Gardens, Belfast BT9 6BS

☎ 028-9066 6595 Fax 028-9066 2835

Maclean Building, Crowmarsh Gifford, Wallingford, Oxfordshire OX10 8BB

☎ 01491-838800 Fax 01491-692345

Parent Body

Natural Environment Research Council, Polaris House, North Star Avenue, Swindon, Wiltshire SN2 1EU

☎ 01793-411500 Fax 01793-411501

www.nerc.ac.uk

Contents

| | |
|--|------------|
| Contents | i |
| Summary | iii |
| 1 Introduction | 1 |
| 2 Recharge and Rainfall | 2 |
| 2.1 Empirical Estimates of Recharge | 2 |
| 2.2 Rainfall data | 3 |
| 3 Monthly Distribution of Recharge | 6 |
| 3.1 Monthly apportionment of recharge | 6 |
| 3.2 Monthly empirical recharge. | 6 |
| 4 Conclusions | 8 |
| References | 9 |
| Appendix 1 Rainfall data | 10 |
| Appendix 2 Linear apportionment of recharge | 11 |
| Appendix 3 Revised empirical model | 18 |

FIGURES

Figure 1 Annual distribution of rainfall – West Bank rain gauges 3
Figure 2 Representative annual rainfall 4
Figure 3 Mean Annual Rainfall – West Bank 5

Summary

This report is a supplement to McKenzie et al (2001; SUSMAQ-REC #4) and describes the determination of monthly recharge values based on the annual calculation method presented in McKenzie et al, (2001; SUSMAQ-REC #4).

1 Introduction

This report addresses the issue of recharge to the aquifers of the West Bank, with particular concentration on recharge to the aquifers that make up the Western Aquifer Basin, prepared by British Geological Survey (BGS) and Palestinian Water Authority (PWA) staff for the Department for International Development (DFID) funded project “Sustainable Management of the West Bank and Gaza Aquifers”. It is intended as an addendum to the previous report (McKenzie et al, 2002) that reviewed previous work on recharge and existing data sources, and needs to be read in conjunction with that work. As a baseline for the future development of a detailed process based model of recharge, an existing empirical model was used to estimate annual mean recharge, distributed spatially across the recharge areas of the various aquifers of the West Bank.

Precipitation over the West Bank is concentrated during the winter months, with a small amount of rainfall in October and November, building to a wet period from December to February, tailing off in March and April. The period May to September is effectively dry. It is logical to expect recharge to be similarly concentrated. Other processes affecting flow within the aquifers, such as abstraction, spring flow and outflow to other aquifers, will show different patterns of seasonality. To model the seasonal differences in groundwater level and flow it is necessary to apportion the recharge to the aquifer correctly in time as well as space. This report extends the existing empirical model from an examination of mean annual recharge to an examination of mean monthly recharge.

Other components of the project have developed a process based recharge model, with closer links to climatic variability, terrain, geology and land use. The resulting model should give the best resolution of the variability of recharge. The work outlined in this short report is not designed to supplant this more detailed study.



Full report/document is not available online