MARD Facilitating Grant FG-9505-2009

Final Report

Tracing the Occurrence and Fate of the Agrochemicals in the Shallow Groundwater Aquifer along the Agricultural ‘Ghor Area’ (Faria- Jiftlek-Jericho) of the Jordan Valley.

(TAGO Project- Tracing Agrochemical Occurrence)

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Abstract

Water resources in the whole of the Middle East area are scarce and in many respects relieving this shortage is the key for peace and stability in the region. It is, therefore, necessary to establish comprehensive monitoring and research programs for the assessment of the main threats and risks to groundwater sustainability and quality in the land jointly inhabited by Palestinians, Jordanians and Israelis. The Ghor area along of the Jordan Valley Rift, where 85% of the agricultural production for the West Bank market and much of the agricultural activity of Jordan takes place, is considered the food basket of the West Bank. It is also a major source of Israeli agricultural products including dates, bananas and vegetables. Due to the low rainfall and the high temperatures common to that area, the Ghor is classified as semi arid and accordingly, irrigated agriculture is dominant. The need for irrigation water results in excessive abstraction from the shallow aquifer, the sole source for water for domestic and agricultural usage for the Palestinians. Past studies indicated a high rate of deterioration of the quality of the groundwater due to the geogenic factors. Evidence of agricultural backflow and anthropogenic contamination of the groundwater was also gathered. The use of agrochemical in considerable amounts with disregard to their toxicity and threat to the environment is widely common in the area. The risk in uncontrolled use of agrochemicals in the Ghor is exacerbated by the lack of institutional controls, environmental awareness and monitoring programs. Any further damage to the quality of water resources and as a result to agricultural production, might constitute a real threat to the economy, public health, quality of life, and political stability of the whole region. Thus, it is necessary to assess the load of agrochemicals in the groundwater and identify temporal and spacial trends in pollutants' concentrations.

In all the collected water samples the concentration of the investigated chemicals was below the detection limit. Consequently, it was decided to modify somewhat the objectives of the joint proposal, the enactment of which was the main objective of the MARD project. A proposal titled "Wastewater from olive oil mills in Israel and Palestine: interactions with soil, organic contaminants and mechanisms of incorporation into soil" was submitted to the DFG Trilateral Collaboration Deutschland-Israel-Palestine Fund in cooperation with Prof. Dr. Gabriele E. Schaumann, University of Koblenz-Landau. The proposal was approved and funded for two years with a total budget of 331,000 Euro.
Introduction

During recent years, water availability and quality are affected by a wide range of human activities which can be observed clearly in areas with high industrial, agricultural activities. Freshwater was critical and still an issue for the people in the whole world. The main water resource in the world is oceans which represent 97% of water supply. Water recourses are surface water (includes rivers, lakes, and man-made dams which represent 1% of the world’s water supply). Groundwater which occurs in different rock types, ranging from ancient crystalline basement rocks (which store small amount of water in their shallow) to alluvial plain sediments.

Water can reach to our bodies not only through direct supply when we feel thirsty but also through fruits and vegetables which are treated with pesticides. Water used for irrigation is considered the largest source of water consumption which accounts for 60 and 90 per cent of annual water consumption in most countries in the reign, which may contains toxic amounts of pesticides used.

In many countries groundwater represent the main source for irrigation and domestic usage typically for drinking, cooking, and personal hygienic supplement. In addition to the wells in different areas e.g. the West-Bank which get the range of 20 to 20 liters per person per day only for domestic usage, of course depending o n the level of affluence of users and the availability of water.

To get safe water, causes of water pollution must be studied for seeking a solution for this problem, one of those causes of water pollution, is pesticides with all types; insecticides, herbicides, fungicides, etc. Pesticides are used to kill the pests and this definition is enough to make us think of the harmful to the environment and human health through usage or even storage. Pesticides include a broad range of organic micro pollutants, and different categories of them have different effects on living organisms, and therefore generalization is difficult. Additionally, pesticides have differed degradation rates and consequently different residuals. The interaction of pesticides with ground water and with soil and surface water is complex. Pesticides are controlled by numerous simultaneous biological, physical and chemical reactions, and with combination of many processes: a) transformation; refers to a biological and chemical process that change the structure of pesticides or completely degrade it, b) transfer; refers to the
way in which pesticide is distributed between solids and liquids (e.g. between soil and soil water), and c) transport; is the movement from one environmental compartment to another such as leaching of pesticides through soil to ground water, valorization to the air or runoff to surface water.

Water resources in the West Bank are groundwater in form of springs and wells in addition to some rainfall harvesting. There are about 360 springs distributed all over the West Bank with total discharge of about 65MCM\(a\). the majority of these springs are located in rural area where water is used for domestic and agricultural purposes, in addition to the springs, 60 groundwater wells tap water from different aquifer systems where the water table is located between 80m and 400m under the surface. These wells abstract 70MCM\(a\), mainly for agriculture purposes. The agriculture sector in the West Bank consumes about 60% of the water, while the rest is used for domestic purposes.

The agricultural sector is the most important economic sector for the Palestinian people and make about 15% of the economic income.

Many challenges are facing this sector with respect to the availability of water resources in terms of quantity and quality. Due to the intensive use of fertilizers and pesticides, residues of these chemicals can reach the ground water aquifer system in a short time. The shallow aquifer in the Jordan valley and the kastic mountain aquifer could be endangered through the uses of these chemicals.

**Area of survey**

The area is near Jericho in the West Bank, Palestine. Jericho is a city located near the Jordan River. It is the capital of the Jericho Governorate, and has a population of over 20,000. Situated well below sea level on an east-west route, 16 kilometers north of the Dead Sea, Jericho is the lowest permanently inhabited site on earth. It is also believed to be the oldest continuously inhabited city in the world.

Jericho's moderate climate makes it a favorite winter resort. It is an important agricultural area, producing fresh fruits and vegetables year round. So due to the low rainfall and the high temperatures common that area , Jericho can be classified as semi-arid where irrigated agriculture is dominate. So high amounts of agrochemicals are used in that area for crop protection.
Geology of the study area:

Jericho is located 258 meters below sea level in an oasis in Wadi Qelt in the Jordan Valley, and locates in the rain shadow of the West Bank and receives about 150mm\text{yr} rainfall, during the winter months which extend from October until April. The average temperature is 24°C during winter season and 30 °C during the summer season.

The Jericho area presents about 80% of the agriculture production for the West Bank market. The low rainfall and the high temperature characterizes that area. Jericho is classified as semi-arid, where irrigated agriculture is dominant. The existence of high and uncontrolled agrochemical usage for crop protection increases the chance for environmental pollution, and especially, the chance for groundwater pollution by pesticides, which creates the need for testing water quality and safety.

Springs and wells of the study area

There are four main spring systems in the Jericho area, the total annual discharge of these springs reached 27 MCM.

- Wadi el-Qilt spring system: The Wadi Qilt basin on the west side of the Jordan River represents a major drainage system from the Judean Mountains area between Jerusalem and Ramallah downwards east to the Jordan Valley.
- Ein Al-sultan spring system: it is located in the northeast of wadi Al-Quilt in Jericho city and related to the upper Cenomanian Aquifer. Its annual flow discharge of about 4 MCM.
- Ein Dyouk spring system: this system is composed of three springs: Dyouk, Newemeh, and Shosha emerging on a fault parallel to the Rift fault.
- Al-Auja spring system: the average annual discharge of this system is about 10 MCM.

There are 58 wells are located in Jericho area as in figure below. These wells abstract 2.5 MCM\text{yr}, from the plio-pleistocene aquifer systems. Wells are spread along Jericho, but the research is concerned more about wells near agricultural areas in which there is an extensive use of pesticides.
Hypothesis and goals of the project

The overall objectives of the project was to strengthen the cooperation between scientists from the region and to provide scientific and statistical data which will make it possible to embark on a major joint project in which the risks to water supplies from pesticide pollution of the groundwater will be assessed.

The tested hypothesis was whether well defined hotspots could account for the presence in groundwater of the pesticides which will be found there or identified in the unsaturated zone above the water table.

The specific targets leading to the fulfillment of these objectives were:

- Establish modes of contact and joint efforts between the participating scientists (e.g., mutual consultations, meetings and workshops).
- Mapping of the occurrence of pesticides in the groundwater and of spacial and temporal trends in their concentrations.
- Definition of the future joint projects and cooperation.
**Pesticides survey**

According to the Palestinian ministry of agriculture in Ramallah, the farmers obtain their pesticides through the ministry and from Israeli dealers. Table 1 summarizes the pesticides used in the West Bank.

Table 1. Pesticides used in the West Bank.

<table>
<thead>
<tr>
<th>Trade Name</th>
<th>Chemical Name</th>
<th>Trade Name</th>
<th>Chemical Name</th>
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</thead>
<tbody>
<tr>
<td>Insegar</td>
<td>Fenoxycarb</td>
<td>Confidor</td>
<td>Imidacloprid</td>
</tr>
<tr>
<td>Tiger</td>
<td>Pyriproxyfen</td>
<td>Marshal 25</td>
<td>Carbosulfan</td>
</tr>
<tr>
<td>Tracer super</td>
<td>Spinosad</td>
<td>Mosblan</td>
<td>Acetamiprid</td>
</tr>
<tr>
<td>Dorsban</td>
<td>Chlorpyrifos</td>
<td>Metasystox</td>
<td>Oxydemethon methyl</td>
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<td>Decis</td>
<td>Deltamethrin</td>
<td>Mitac</td>
<td>Amitraz</td>
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<td>Divipan 100</td>
<td>Dichlorvos</td>
<td>Indar</td>
<td>Fenbuconazole</td>
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<tr>
<td>Runer</td>
<td>Methoxyfenozide</td>
<td>Anvil</td>
<td>Hexaconazole</td>
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<td>Cymbush 10</td>
<td>Cypermethrin</td>
<td>Ofir</td>
<td>Penconazole</td>
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<tr>
<td>Vertimec</td>
<td>Abamectin</td>
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</table>

In order to verify this data and to specify the most used pesticides, the Palestinian team conducted a survey among the farmers in Jericho area. The survey indicated that the most used pesticides are insecticides: Abamectin, Imidacloprid, Cyfluthrin and Acequinocyl. Besides, it was found that one chemical can be available for the farmers under several trade names.

**Sample collection and extraction**

Water sampling that covered the entire Ghor district was conducted jointly by the Palestinian and Israeli teams. Collection of groundwater samples occurred in 2 stages (dry period and rainy period) for the purpose of measuring the presence of pesticides in groundwater extracts. Grab samples were collected in glass containers and iced and then refrigerated at 4°C from the time of collection until extraction. The water samples were extracted twice in separatory funnels with a mixture of hexane:ethyl acetate. The organic phase was collected, dried over anhydrous sodium sulfate and concentrated by means of evaporation with a stream of nitrogen.
**GC-MS analysis**

The analysis of the pesticides in the water samples was carried out at Volcani Centre using an Agilent GC-MS (6890N). The GC-MS equipped with a 30 m x 0.25 mm DB-5MS column (J & W Scientific). Injector and detector were 250 °C and 300 °C, respectively. Injection volume was 1 µL. The GC-MS column oven temperatures were as follows: initial temperature, 50 °C, hold for 2 min; then increased at 20 °C min⁻¹ to 100 °C, then at 10 °C min⁻¹ to 200 °C; and finally at 20 °C min⁻¹ to 300 °C. Identification of the pesticides was carried out by two GC-MS libraries: RTL pesticides and NIST 98.

In all the collected water samples the concentration of the investigated chemicals was below the detection limit.

**Cooperation activities and DFG grant preparation**

Interaction between the Palestinian and Israeli teams was conducted on a continuous basis through E-mail, telephone calls and meetings at Volcani and at Dier Hijla near Jericho. Dr. Ahmed Nasser and Prof. Uri Mingelgrin joined Dr. Amer Marei and his students twice in collecting the water samples through the entire Ghor district.

In all the collected water samples the concentration of the investigated chemicals was below the detection limit. Consequently, it was decided to modify somewhat the objectives of the major project, the preparation of which was the main objective of the present MARD project. A proposal titled "Wastewater from olive oil mills in Israel and Palestine: interactions with soil, organic contaminants and mechanisms of incorporation into soil" was submitted to the DFG Trilateral Collaboration Deutschland-Israel-Palestine Fund in cooperation with Prof. Dr. Gabriele E. Schaumann, University of Koblenz-Landau. The composition of the research teams was modified; the Israeli group includes Dr. Ahmed Nasser and Dr. Michael Borisover and the Palestinian team includes Dr. Amer Marei and Dr. Jawad Hassan. The proposal was approved and funded for two years with a total budget of 331,000 Euro. The American scientist Dr. Marcos Cheney is not part of the DFG grant but he will cooperate with the Israeli team and will take part in the research.

Dr. Ahmed Nasser visited Dr. Marcos Cheney at University of Maryland Eastern Shore, and discussed with him the DFG grant. Both scientists developed a plan to cooperate in the new project, essentially on the subject of dewatering of the wastewater produced from olive oil mills.
References  (sources relevant to the subject matter of the project)


Appendix I: Approval letter of the DFG Trilateral Collaboration Deutschland-Israel-Palestine

Deutsche Forschungsgemeinschaft

Frau
Professor Dr. Gabriele Schaumann
Universität Koblenz-Landau
Campus Landau
Fachbereich 7 - Natur- und Umweltwissenschaften
Institut für Umweltwissenschaften
Fortstraße 7
56070 Landau

21.07.2010
GZ: SCHA 849/13-1
AOBJ: 579149

Sehr geehrte Frau Professor Schaumann,

die Deutsche Forschungsgemeinschaft bewilligt Ihnen und Ihrer Hochschule eine Sachbeihilfe

entsprechend Ihrem Antrag, den Sie gemeinsam mit Herrn Dr. Mikhail Borisover, Herrn Dr. Amer Marei Sawaiha, Herrn Dr. Jawad Hasan und Herrn Dr. Ahmed Nasser zum Thema "DFG Trilateral collaboration Deutschland-Israel-Palestine: Wastewater from Olive Oil Mills in Israel and Palestine: Interactions with Soil, Organic Contaminants and Mechanisms of Incorporation into Soil" gestellt haben.

Im Einzelnen werden Ihnen und Ihrem Kooperationspartner die folgenden Mittel bewilligt:

<table>
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<tr>
<th>Schlaufhilfe</th>
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<tr>
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<td>80h/Monat</td>
<td>24 Mon.</td>
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<td>Mikhail Borisover, Israel</td>
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DFG
| Sonstige Personalkosten | Laboratory technician, 2 years, Israel, (Bezahlung insgesamt maximal wie nebeneinstehend) | 24.000 |
| Sonstige Personalkosten | PhD student, 2 years, full position, Israel, (Bezahlung nach Ortsüblichkeit, insgesamt maximal wie nebeneinstehend) | 26.000 |
| Sonstige Personalkosten | Student assistant, 2 years, 80th/month, Israel, (Bezahlung nach Ortsüblichkeit, insgesamt maximal wie nebeneinstehend) | 19.000 |
| Sachmittel | | 37.334 |
| Programmflaumshale | | 21.300 |
| Amer Marei Sawalha, Palästina | finanziert durch DFG | |
| 1. Förderabschnitt | 24 Mon. | | 
| Personalmittel | | 
| Sonstige Personalkosten | Laboratory technician, 2 years, Palestine, (Bezahlung insgesamt maximal wie nebeneinstehend) | 12.000 |
| Sonstige Personalkosten | PostDoc Position, 2 years, Palestine, (Bezahlung nach Ortsüblichkeit, insgesamt maximal wie nebeneinstehend) | 27.000 |
| Sonstige Personalkosten | Student assistant, 2 years, 80th/month, Palestine, (Bezahlung nach Ortsüblichkeit, insgesamt maximal wie nebeneinstehend) | 16.000 |
| Sachmittel | | 99.760 |
| Investitionsmittel | | 
| Geräte über 10.000 Euro | TOC supplementary for soil analysis | |
| Programmflaumshale | | 33.100 |


Die genannten Geräte werden Ihnen als persönliche Leihgabe für die Dauer der Forschungsarbeit zur Verfügung gestellt.

Mittel bis zur Höhe von 10.500 Euro werden zur Beschaffung eines TOC supplementary mit der Maßgabe zur Verfügung gestellt, dass das TOC supplementary für das bewilligte Forschungsvorhaben verwendet wird. Soweit eine spätere Verwertung zu Erfüllen führt, sind diese anteilig an die DFG abzuführen.

Dem darüber hinausgehenden Antrag konnte leider nicht entsprochen werden.

Für die Bezahlung von wissenschaftlichen Mitarbeiterinnen oder Mitarbeitern nach BAT IIa/E13 beachten Sie bitte die Regeln unter "Personal" in den Verwendungsrichtlinien der DFG.

Es gilt das an Ihrer Einrichtung maßgebliche Tarifrecht.


Sofern das an Ihrer Einrichtung maßgebliche Tarifrecht auf einem Haustarif beruht und sowohl vom TVL als auch vom BAT abweicht, können die bewilligten Mittel für Personal verwendet werden, das Tätigkeiten wahrmimmt, die den Tätigkeitsbeschreibungen der korrespondierenden Vergütungsgruppen des BAT entsprechen.
Die bewilligten Sachmittel können von Ihnen und Ihrem Kooperationspartner für Verbrauchsmaterial, kleinere Geräte (mit einem Preis bis zu 10.000,00 Euro), Reisen und Sonstige Kosten verwendet werden, sofern sie für die Durchführung des Vorhabens notwendig sind. Die Sachmittel dürfen aber nicht für die sich aus diesem Schreiben ergebenden, ausdrücklich abgelehnten Positionen und auch nicht für die "nicht abrechenbaren Kosten" nach Ziffer 6 der Verwendungsrichtlinien (DFG-Vordruck 2.02 - 8/09 - II 3) eingesetzt werden.

Bei Fragen zur finanziellen Abwicklung der bewilligten Mittel wenden Sie sich bitte unter Angabe des Geschäftszeichens SCHA 849/13-1 und des dazugehörigen Abrechnungsobjektes 579149 an den Bereich Prüfung und Abrechnung, E-Mail FIN2@dfg.de.

Über die Verwendung der Programmapauschale entscheidet Ihre Hochschule, zu den Programmapauschalen siehe auch Ziffer 1.2 der Verwendungsrichtlinien (DFG-Vordruck 2.02 – 6/10 – II 3).

Bewilligte Publikationskosten stehen ausschließlich für die Veröffentlichung der wissenschaftlichen Ergebnisse nur dieses Projektes zur Verfügung. Sie sind gesondert spätestens zwei Jahre nach Projektende beim Bereich Prüfung und Abrechnung, E-Mail FIN2@dfg.de, abzurufen.

Die beigefügten Verwendungsrichtlinien (DFG-Vordruck 2.02 – 8/09 – II 3) sind Bestandteil dieser Bewilligung.

Ihre Hochschule wird mit einem Schreiben gleichen Datums zum obigen Geschäftszeichen auch über den Umfang der Bewilligung informiert.

Sie werden gebeten, die Beauftragte Ihrer Hochschule für Angelegenheiten der Deutschen Forschungsgemeinschaft Frau Professor Dr. Gabriele Schaumann, Fortstraße 7, 76829 Landau, von dieser Bewilligung zu unterrichten.

Mit Annahme dieser Bewilligung verpflichten Sie sich, gleich nach Abschluss Ihres Projekts über die Ergebnisse zu berichten (siehe "Leitfaden für Abschlussberichte" in den beigefügten Verwendungsrichtlinien, Ziffer 16); wir haben darauf als Termin vorläufig den 01.09.2012 notiert. Wenn Sie jedoch einen Fortsetzungsantrag zu diesem Projekt stellen, so fügen Sie bitte nur diesem einen Zwischenbericht bei.


Die Deutsche Forschungsgemeinschaft wünscht Ihnen für Ihre Arbeit guten Erfolg.

Mit freundlichen Grüßen

[Unterschrift]

Dr. Patricia Schmitz-Müller