University of Redlands

**Spatially Interactive Literature Analysis System (SILAS):
An Interactive Tool to Study the
Narrative Landscape of Ancient Texts**

A Major Individual Project submitted in partial satisfaction of the requirements
for the degree of Master of Science in Geographic Information Systems

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July, 2008

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Narrative Landscape of Ancient Texts

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The report of Stephen T. Benzek is approved.

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July, 2008

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ABSTRACT

The Spatially Interactive Literature Analysis System (SILAS): An Interactive Tool to Study the Narrative Landscape of Ancient Texts

by
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College-level students of Christian scripture face the challenge of critically reading the text while separating it from the familiar theological context. This can be addressed by requiring students to create maps of relevant data, but it raises challenges in cartography, temporal representation and analysis. Students either laboriously hand draw maps or attempt to use web-based tools without much regard to time or spatial analysis. A Geographic Information System (GIS) can help, but the large investment in learning software is often not worth the effort. The Spatially Interactive Literature Analysis System (SILAS) is a GIS-based study tool designed to allow students to integrate historical data, edit and annotate geospatial content, and create and print maps. Computer-based GIS technologies, manual techniques, usability issues and integrating text with geography are examined. Initially focused on the four gospels in the New Testament, SILAS can serve as a template for incorporating other texts, Christian and otherwise.

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List of Acronyms

ADF	Application Development Framework
C.E.	Common Era
ESRI	Environmental Systems Research Institute
GIS	Geographic Information System
IDE	Integrated Development Environment
IIS	Internet Information Server
MIP	Major Individual Project
MS GIS	Master of Science in Geographic Information Systems
MXD	ArcMap Document
NRSV	New Revised Standard Version
SDE	Spatial Data Engine
SILAS	Spatially Interactive Literature Analysis System
SQL	Structured Query Language
SRTM	Shuttle Radar Topography Mission
TOC	Table of Contents
VBA	Visual Basic for Applications

1. Background and Introduction

1.1. Background

The written word, in texts and other documents, is the primary focus of students in the humanities. Yet those students often have to do without tools to experiment with their subject matter unlike science students who perform laboratory assignments to reinforce concepts. Hands-on experimentation with the historical, geographical and political factors that influenced an ancient text, for example, could help students understand and engage the text in a way that reading alone could not do. It could encourage the development of critical reading skills that are particularly important when students need to navigate the deep investment they bring to the classroom if the text is of a religious nature.

Putting a text into its geographical and temporal context has been shown to de-couple early Christian texts from their familiar interpretations and has been useful in getting students to begin to read the material from a critical, historical perspective (Larsen, 2007b). This de-coupling is aided by the wealth of geographic—and to a lesser extent chronological—cues and references in texts such as the New Testament.

A Geographic Information System (GIS) is a well-suited tool to complement the study of text with a geographical and temporal context not unlike the way that laboratory experiments complement the study of chemistry or physics. When a GIS provides that context, students may be able to experience the narrative landscape of historic text in a way that they cannot do with written words alone.

1.2. Statement of Problem

College-level students of Christian scripture face the challenge of understanding the historical associations and implications of the text while separating it from the familiar theological context. “The Sermon on the Mount” (Matthew 5:1-7:29), for example, with references to the “Kingdom of God” and “serving two masters” can be reoriented in the geographic space of the Roman Empire to reveal nuanced references to the prevailing political structures if the reader looks beyond the theology.

Engaging the student to read scripture with a critical perspective can be addressed by attending to the geographical detail that permeates much of the text. Assigning students of the New Testament the task to create maps of relevant historical events and places presents challenges in cartography, temporal representation, and analysis (Larsen, 2007a). Students spend significant time either laboriously hand-drawing maps or attempting to use geographical annotation tools in virtual globes such as Google Earth to create simple, single-layer representations without much regard to time, causality, or spatial analysis (Larsen, 2007a).

Students in a Christian Scripture class at the University of Redlands created hand drawn maps of the areas and events in their texts (Figure 1). This example looks rudimentary at

first, but it clearly calls attention to the density of particular loci of the work of the apostle Paul. Only a map could so effectively illustrate Paul's early efforts to spread Christianity beyond its origins in Jerusalem and Galilee.

Figure 1. Student hand drawn map of Roman Empire from Christian Scripture class at the University of Redlands, Fall 2007.

Creating maps has great pedagogical potential, but the limitations of the current manual process fail to exploit the rich possibilities. New GIS and temporal representation techniques have created tools that hold great promise in bringing relevance and deeper understanding to historical texts such as the Bible, but the development and pedagogical investment is high. The solution should not merely be a visualization—nor should it consist of mechanical button-clicking in a computer-based GIS that is time-consuming to learn. This is the challenge of SILAS.

1.3. Client

The client for this project was Dr. Lillian Larsen of the Religious Studies Department of the University of Redlands in Redlands, California. She has used maps to help her Christian Scripture students develop critical reading skills, but needs SILAS to support a deeper understanding that would not otherwise be possible with static maps.

Dr. Larsen has provided invaluable assistance in the development of SILAS by:

- Providing vetted source material for the historical texts used in this project.

- Applying her expertise in religious history to direct the focus and emphasis of the project in both time and place.
- Evaluating and providing feedback on draft versions of SILAS.
- Providing University of Redlands students to assist in the development and testing of the tool.
- Providing initial references to citable resources (books, maps, papers, periodicals).
- Assisting in the acquisition of scholarly resources needed to complete this project.

1.4. Literature Review

The opportunities and challenges of this project are intimately related to the following areas of research: teaching history, teaching the Bible, representing history in a GIS, and the value of maps and a GIS in teaching.

One education scholar states that a major requirement of teaching history, or more generally social studies, is to engage the student in active learning that provides a “conceptual framework with which to connect all the loose bits of information” (Alibrandi, 2003, p. 10).

The idea of connection is advanced by biblical scholar Fernando Segovia who concludes that readers of the Bible should analyze three worlds: the when and where of the text as written, the “world of modernity,” and the world in which they live today. His “world of modernity” is the current structure of “Western imperialism that dominates current biblical interpretation,” (Segovia, 2000, pp. 119-132).

These three worlds begin to highlight the intricacies inherent in modern biblical study. Add to this an African theologian’s observation that biblical text “travels in the world and participates in history, continuing to write its story far beyond its original context and readers” and the spatio-temporal complexities of the text begin to emerge (Dube, 2000, p. 17).

It is tempting to say that a GIS can sort out the complex problems of time and space in historical texts such as the Bible. The GIS allows the user to integrate multiple sources, create visualizations, and perform analyses that otherwise would not be possible. This benefit may outweigh the challenges associated with gathering and organizing time-dependent data for historical scholars (Gregory, 2003). This is evidenced by a proliferation of historical GIS applications as well as historic map services available on the Internet (Dando, 2007; Getty Research Institute, 2007; Gregory, 2007; Knowles, 2002; University of California at Berkeley, 2007; University of California at Santa Barbara, 2007; University of North Carolina at Chapel Hill, 2007). Scholars of both history and geography agree that such applications are, however, complicated by an almost complete lack of accurate geographic and feature information (Gregory, 2003; Knowles, 2002).

The proliferation of biblical maps in both scholarly and popular sources (Ehrman, 2000; Ferguson, 2003; Jewish National and University Library, 2007; Russell, 2007),

authoritative geographical resources (Talbert & Bagnall, 2000), and online services (Cartography Associates, 2007; University of North Carolina at Chapel Hill, 2007) helps to solve the problem of obtaining accurate historical geographical data, but georeferenced biblical-era content is not readily available, for download or otherwise.

Representing time in the typical GIS layer-based data model has always been a challenge (Gregory, 2003). This shortfall in modern GIS systems is beginning to be addressed by the Temporal Analyst tool (DHI Software, 2007), the Alexandria Digital Library (University of California at Santa Barbara, 2007) with its temporal search, and case studies of GIS used in historical research presented by pedagogical experts (Knowles, 2002).

GIS is increasingly used as a tool for historical research and study, but far fewer are using it as a teaching tool. Educators state that a GIS can change a student's viewpoint of data and help them to "escape the ingrained assumptions of their individual experiences" (Sinton & Lund, 2007, p. 14). Examples include a religious scholar who used a GIS system to teach a seminar on the Salem witch trials (Ray, 2002) and a history professor who used it to help students examine the politically-charged redistricting process (Churchill, 2008). Knowles and Hillier describe other examples of using a GIS to teach history (2008), but at least one education scholar states that the technological challenges have prevented more widespread use (Wiegand, 2006).

Many powerful and complex GIS tools are widely available, but few have been adapted for use in the classroom environment (Wiegand, 2006). One social science scholar enthusiastically advocates leveraging the skills of the technology-savvy Internet generation to incorporate GIS into the liberal arts, but then describes the importance of georectification and digitizing that require significant training to master (Hillier, 2008).

There are many GIS-like visualizations of Biblical material on the Internet and available for sale or free download (Barrett, 2008; He Lives Ministries, 2008; Sunday Software Inc., 2008). None is designed for classroom use nor do they permit the user to create their own maps, add annotations, and generate symbology based on their own critical reading of the text.

1.5. Scope

The potential scope of the prototype SILAS was wide-ranging and multidimensional (time, geography, section of the Bible) and could include such ranges as:

- Time: From the birth of Christ to present day.
- Space: Ranging from a single city, the Roman Empire, or the entire world.
- Biblical text: Range could be from a single verse in the Bible to the entire text.

To achieve this scope, georeferencing worldwide events and places that have influenced biblical study over the past two thousand years would be required. This project will instead focus on the following ranges:

- Time: 0 C.E. to 200 C.E.
- Space: the extent of the Roman Empire in the above time range.
- Biblical text: the four Gospels in the New Revised Standard Version (NRSV) of the Bible.

Data acquisition for this project involved the client choosing content to analyze and defining authoritative sources. Georeferencing the content was done by the author. To the extent possible, authoritative sources of data already in GIS-ready formats (shapefiles and rasters) were utilized.

1.6. Goals and Objectives

This project developed a prototype of an interactive GIS-based teaching tool called SILAS. It was conceived to be used by students to critically examine the four gospels of the NRSV Bible (i.e., the gospels according to Matthew, Mark, Luke and John).

Goals at the start of this project consisted of the following:

- 1) Digitally integrating data from both ancient and contemporary maps of geographic regions relating to these four gospels.
- 2) Developing geospatial data referencing historical events, places, routes and the cultural and political landscapes relevant to the texts.
- 3) Using a web-based interface or other no-cost client application.
- 4) Providing a method to produce, save and print student-created maps.
- 5) Implementing a template-based design that allows for future development beyond the prototype stage.
- 6) Including supporting documentation to allow the client to incorporate additional content and expand the geographic, temporal and historical scope.

SILAS could later be extended to the related challenge of enhancing cultural awareness training for military and diplomatic personnel on assignment in regions with complex religious histories that shape present-day belief and values systems.

Development of SILAS augmented the author's skills utilized as webmaster for the Topographic Engineering Center; provided an opportunity to learn about visualization and analysis of cultural information in geographic information systems; and served a long-held interest in interpreting biblical passages in a non-theological, contemporary context.

GIS has traditionally and most often been applied to issues of natural resource management. Developing a GIS project to support pedagogical needs in the humanities provided a unique challenge well beyond the bounds of more conventional environmental analyses.

The choice of this project will further provide exposure to diverse fields of study—education, history, religious studies, geographic information science, cartography,

usability and software development—that can help inform future career decisions and directions.

2. Methodology

The development of SILAS was divided into eight major tasks that focused on heavy user and client involvement. Multiple testing on increasingly complex versions of the system reduced the risk and helped ensure project success. Budgetary, schedule and risk considerations as well as assumptions that affected the underlying methodology are described below.

2.1. Major Tasks Summary

These tasks show the primary decision points that impact whether the design needs to be modified before the next task was started (Figure 2).

Figure 2. Workflow diagram of major tasks.

2.1.1. Requirements Analysis and Definition (Task 1)

This task used information from the literature review in discussions with the client to get her ultimate vision of how students would use SILAS. The output was a set of finalized requirements for SILAS.

2.1.2. Initial Proof of Concept (Task 2)

The Initial Proof of Concept consisted of creating mock-up data layers in the form of transparencies to represent data that might be included in SILAS. A student exercise to use these mock-up layers was conducted prior to continuing to Task 3.

2.1.3. Create User Interface Mock-ups (Task 3)

Mock-up screen shots of the SILAS to simulate the look and functional layout of the operational system were created to further refine the interface requirements and drive the backend design.

2.1.4. Develop Conceptual Geodatabase Design (Task 4)

The conceptual geodatabase design of this task contained the layers, attributes, interrelationships and formats of the data necessary to complete the project.

2.1.5. Develop Pre-prototype ArcMap System (Task 5)

The pre-prototype required populating the geodatabase and developing the map creation and analysis tools. The result was an operational SILAS system that included the data layers and functionality executed within the ArcMap framework.

2.1.6. Create Prototype Server/Client System (Task 6)

Translating Task 5 into an ArcGIS Server/Web Browser architecture with fully functioning user interface was the output of this task.

2.1.7. Test and Evaluation (Task 7)

This task consisted of evaluating the completed system with the assistance of student volunteers.

2.1.8. Delivery of Completed System with Documentation (Task 8)

The completed system consisted of a database, geodatabases, custom web applications for both the map and the scripture text search, stand-alone ArcMap version of the system and documentation consisting of online help, a tutorial and administrators guide.

2.1.9. Academic Documentation (Task 9)

This final task consisted of preparing a poster, digital data and other ancillary subtasks required to meet the graduation requirements for the MS GIS program.

2.2. System Requirements

Establishing system requirements is a critical part of project design, be it in construction, computer software or even event planning. Defining the requirements for SILAS was challenging because neither the client nor the author were experts in GIS at the beginning

of the project. Likewise, only the client had expert knowledge of religious history, ancient Hebrew and Christian Scripture and pedagogy. Yet, the goals and objectives of paragraph 1.6 needed to be met.

The system requirements below were divided into “functional requirements” that relate to specific functions SILAS must perform and “non-functional requirements” that include features, characteristics and constraints that either define a satisfactory system or set forth criteria that could be used to judge the operation of SILAS.

2.2.1. Functional Requirements

Table 1 contains the set of functional requirements that SILAS is designed to satisfy. Data for layers indicated in section 3.2.2 were taken from the Harper Collins Study Bible (Attridge & Meeks, 2006), the Barrington Atlas of the Greek and Roman World (Talbert & Bagnall, 2000) and from other sources as determined by the client. These functional requirements included processes and tasks SILAS must perform, information it needs to contain and activities and services it must provide. The author assigned one of three priorities to each requirement to reflect discussions with the client about her needs for the system:

1 – Mandatory, 2 – Desirable, 3 – Optional.

Table 1. Functional Requirements

Number	Description	Priority
	<i>Perform the following overall functions:</i>	
1	The system shall permit the mapping of all places mentioned in the four Gospels in the Bible without having to look up coordinates (Matthew, Mark, Luke and John)	1
2	The system shall use the “New Revised Standard Version” of the Bible	1
3	The system shall have an extent equal to or greater than that of the Roman Empire from 0 C.E. to 200 C.E.	1
4	The system shall include data representing the time period 0 C.E. to 200 C.E.	1
5	The user shall be able to save and print maps	1
	<i>Perform operations on data as follows:</i>	
6	The user shall be able to display an overlay of Roman roads	1
7	The user shall be able to display a base map of physical geography (terrain, hydrography, shorelines)	1
8	The user shall be able to display populated places	1
9	The user shall be able to display Roman empire boundaries and divisions	1
10	The user shall be able to quickly identify the scripture verses that contain references to a particular place	2
11	The user should be able to display an overlay of Trade Routes	2
12	The user should be able to display an overlay of the Jewish diasporic communities	2
13	The user shall be able to display historical events	3
14	The user may be able to display population distribution	3
15	The user may be able to display overlays of historical maps	3
16	The user may be able to display overlays of climate data	3
	<i>Create and annotate maps as follows:</i>	
17	The user shall be able to select which layers to display.	1
18	The user shall be able to add/modify/delete labels	1
19	The user shall be able to add/modify/delete annotations	1
20	The user should be able to create annotations that include images	2
21	The user should be able to choose symbology for layers	2

2.2.2. Non-functional Requirements

SILAS is also designed to satisfy a set of non-functional requirements (Table 2). Nonfunctional includes features, characteristics and constraints that either defined a satisfactory system or criteria that can were used to judge the operation of SILAS. They were prioritized as follows:

1 – Mandatory, 2 – Desirable, 3 - Optional.

Table 2. Non-Functional Requirements

Number	Description	Priority
22	An undergraduate humanities student with computer experience but no experience with maps or cartography shall be able to create and print a map independently after no more than 30 minutes of classroom instruction or after no more than 60 minutes of self-guided instruction.	1
23	The system shall utilize client software that is either free or already available on computers at the U or R.	1
24	The system shall be documented so that it can be maintained and extended to other texts and applications.	1
25	The system shall include electronic versions of both user help and a tutorial for student operation.	1
26	The system shall allow up to 5 concurrent users	1
27	The system should be able to run on student's personal computers without the purchase of additional software	2
28	The user interface should include a Wizard-like interface to take the student through the map creation process with visual feedback as selections are made.	2
29	The system should allow up to 20 concurrent users	2

2.3. Schedule

The schedule, illustrated with milestones and deliverables in Figure 3 were divided up into the nine tasks of paragraph 2.1. Tasks in red require client involvement.

Figure 3. SILAS Project Schedule

Deliverables in Figure 2 are summarized below (delivery dates in parentheses):

- Task 1: Requirements Analysis and Definition (2/13/08)
- Task 2: Initial Proof of Concept (2/13/08)
- Task 3: SILAS User Interface Mock-up (2/13/08)
- Task 4: Geodatabase Design (3/18/08)
- Task 5: Pre-prototype ArcMap SILAS system (4/1/08)
- Task 6: Prototype SILAS Client/Server System (final configuration) (6/10/08)
- Task 7: Test and Evaluation (6/11/08)
- Task 8: Complete System and Documentation (6/27/08)
- Task 9: Completion of Academic Documentation (MIP report, final version, with poster, digital data and all documentation for graduation) (7/08)

2.4. Budget

The tasks in Figure 3 are estimated to have taken approximately 788 hours, distributed as follows:

- Task 1: Requirements Analysis and Definition (40 hours)
- Task 2: Initial Proof of Concept (60 hours)
- Task 3: SILAS User Interface Mock-up (40 hours)
- Task 4: Geodatabase Design (40 hours)
- Task 5: Pre-prototype ArcMap SILAS system (160 hours)
- Task 6: Prototype SILAS Client/Server System (200 hours)

- Task 7: Test and Evaluation (8 hours)
- Task 8: Completed System and Documentation (60 hours)
- Task 9: Academic Documentation (180 hours)

2.5. Risk Areas

The most significant risk areas identified for SILAS involved obtaining data and defining a system architecture. Identifying these and other risk areas early in the project and executing mitigation strategies was critical in overcoming the challenges.

2.5.1. Obtaining and Georeferencing Data

It would be a much easier task to obtain data for a geospatial analysis of 2000 census data for a county in Illinois than it was to find data about 1st century Palestine. Not only were data in GIS-ready format nearly impossible to find for any 1st century location, it was also difficult to find contemporary GIS data for most places outside of the United States.

Obtaining data for an historical GIS application is a well known problem (Gregory, 2003; Knowles, 2002) that was addressed by hand-digitizing historical data from paper maps and relying on a worldwide network of peer researchers for information. The University of Redlands may hire support staff to help with future projects.

2.5.2. Determining Appropriate Data Combination

Data decisions demanded significant input from Dr. Lillian Larsen, the client, since it required the expertise of a biblical scholar with expert-level knowledge of the pedagogical possibilities of SILAS. The access she kindly granted as well as her enthusiasm for the project made this a painless task.

2.5.3. Designing the User Interface

Creating a powerful server-based system for GIS data is of little benefit if the user interface is difficult to use or has an annoying—and ultimately fatal—quirk that users will not tolerate. This is especially critical for a system like SILAS that involves users unfamiliar with geospatial content.

The student exercises planned for SILAS as well as the user interface mock-up task detailed in paragraph 3.2 greatly reduced the risk inherent in the interface design.

Decisions on the system architecture also influenced the interface. Leveraging the extensive usability testing that ESRI has already built into many of their products reduced the overall risk.

2.5.4. Representing Time in a GIS

Representing the temporal aspect of SILAS data was difficult given the other higher priority to let users edit and annotate data (a trade-off that may, in fact, need to be re-evaluated). The ArcMap suite of products does not have an easily-implemented “time

slider” control nor was there a single ArcGIS web application that the author has encountered that implements such a control with the ability to edit data.

This risk area was addressed by reserving the optional, yet desirable, requirement to represent time in SILAS for a later version.

2.5.5. Uncertainty in the System Architecture

Defining the system architecture was a substantial risk area because of the many options available. MS GIS course offerings did not keep up with the demands of the developing SILAS system. This problem was largely mitigated by leveraging the highly accessible GIS experts and training opportunities in the Redlands area.

2.6. Assumptions

Assumptions necessary to finish the project (ultimately validated at completion) were as follows:

- The client will provide timely guidance or input as required by the tasks in the schedule (Figure 3).
- Coursework will not unduly influence the schedule or cause changes in the scope.
- Training and coursework will provide the skills necessary to complete the tasks.
- Limited advisor availability between March and May, 2008, due to a planned overseas trip will not affect progress.

3. Design

The design exploration of SILAS involved several versions from initial proof of concept to prototype deliverable—all of which benefitted from the valuable feedback of undergraduate students in religious studies who evaluated the system. This user input provided both confirmation of design choices and guidance on improvements.

3.1. Initial Proof of Concept

This initial version of SILAS did not require a computer to use nor did it require any a priori knowledge of maps or geographic concepts. Its purpose was to acquaint students with the GIS concepts of scale, layers and annotation and to ascertain the extent to which GIS-like components can encourage critical reading of portions of the New Testament.

3.1.1. Data Acquisition

The data required for the Initial Proof of Concept were limited to the region of 1st century Palestine and consisted of the items indicated in Table 3.

Table 3. Data acquired for the Initial Proof of Concept SILAS

Name	Type	Source
Port Cities Places mentioned in Matthew and Mark gospels	Point	ESRI Data & Maps, Cities (retrieved from Redlands Institute shared drive R:\GIS\ESRI\Data\Data&Maps_2007Update\world\data\cities.sdc\cities) (ESRI, 2007b) Harper Collins Study Bible (Attridge & Meeks, 2006) Getty Thesaurus of Geographic Names (Getty Research Institute, 2007)
Roman roads	Line	Barrington Atlas of the Greek and Roman World (Talbert & Bagnall, 2000)
Shaded relief (background)	Raster	SRTM 90m Digital Elevation Data (Consultative Group on International Agriculture Research Consortium for Spatial Information (CGIAR-CSI), 2008)
Atlas-style map of contemporary Israel and Palestine Atlas-style map of contemporary southern California	Multiple	ESRI ArcIMS Image Service “ESRI_World” (ESRI, 2008d)

The data were loaded into ArcMap as feature classes and raster data with the exception of the Roman roads which had to first be hand digitized at the 1:500,000 scale using scans of the Barrington Atlas (Talbert & Bagnall, 2000).

3.1.2. Implementation

To simulate the concept of map layers, the data of Table 3 were formatted in ArcMap, exported in TIF format, edited in Adobe Photoshop and finally printed on transparent acetate media. This allowed the student user to “layer” the data in a manner similar to a GIS, add annotations, and create a map using multiple data sources. ArcMap was used to add cartographic markers, labels, a scale bar and north arrow while Adobe Photoshop was used to add alignment guides, edit the legend so it appeared to “build” with each layer and to complete minor edits to improve label visibility. Figure 4 shows a schematic of the transparency layers being assembled to create a complete map. The four alignment guides are circled.

Figure 4. Transparency layers that combine to form Proof of Concept map.

The layers created from the data allowed students to visualize clustering of places mentioned in books of the gospels, compare the distribution, and look at the proximity of Roman roads and port cities. To help the students get a sense of the physical size of the region, an additional layer showing a portion of the coast of southern California positioned to mimic the Mediterranean coast was included (see Figure 5).

Figure 5. Initial Proof of Concept layer showing southern California for scale comparison.

3.1.3. Student Exercise

The evaluation of the Proof of Concept SILAS took place on February 13, 2008, in Lewis Hall with the participation of 12 undergraduate religious studies students enrolled in classes with the client, Dr. Lillian Larsen (also present). The transparency layers (with the bottom-most shaded relief layer printed on paper), multiple copies of NRSV Hebrew and Christian Scripture, felt-tipped markers for annotating the layers, and printed excerpts of geographically rich passages from the Matthew gospel were distributed (see Table 4). Half of the printed excerpts had geographic locations printed in **bold** (see Appendix A) to aid in finding features to annotate while the remainder had no such treatment.

Table 4. Citations from the Matthew Gospel with Places Mentioned (Exercise Handout)

Chapter and Verse	Places Mentioned
<i>Woes to Unrepentant Cities</i>	
11:20-21	Chorazin, Bethsaida, Tyre, Sidon
11:22	Tyre, Sidon
11:23-24	Capernaum
<i>Jesus heals the Sick in Gennesaret</i>	
14:34-36	Gennesaret
<i>The Canaanite Woman's Faith</i>	
15:21-28	Tyre, Sidon
15:29-31	Sea of Galilee
15:32-39	Magadan
<i>Peter's Declaration about Jesus</i>	
16:13-20	Caesarea Philippi
<i>Jesus Again Foretells His Death and Resurrection</i>	
17:22-23	Galilee
<i>Jesus and the Temple Tax</i>	
17:24-27	Capernaum
<i>Teaching about Divorce</i>	
19:1-10	Galilee, Judea, Jordan
<i>Jesus Heals Two Blind Men</i>	
20:29-34	Jericho
<i>Jesus' Triumphal Entry into Jerusalem</i>	
21:1-9	Bethpage, Mount of Olives, Nazareth, Galilee
<i>Jesus Cleanses the Temple</i>	
21:12-17	Bethany

The exercise began with the students dividing into groups of two or three followed by the author handing out the shaded relief base layer (printed on paper) and providing the transparencies of maps of contemporary Israel and Palestine and southern California. This was intended to orient the students to the tool and to give them a frame of reference to gauge distances in local terms. The fact that the distance from Sidon to Joppa is comparable to the distance from Los Angeles to San Diego becomes apparent (as does the challenge of making such a journey without the aid of an automobile).

The students were then provided the three layers, respectively, containing port cities, places mentioned in Matthew, and Roman roads. They were supplied with printed excerpts of Matthew passages from Table 4 with the assignment to annotate the Matthew layer with the chapter and verse citations of the places mentioned. Students did not have to determine coordinates of these places since they were already marked and labeled on the Matthew transparency layer.

To evaluate the challenge of identifying place names in the text, half of the students were provided an excerpt of Matthew with the places highlighted in bold (Appendix A) while the remainder received no such highlighting.

After allowing approximately 15 minutes for map annotation, the students were asked to discuss the process and their findings. They then received a similar layer of places mentioned in Mark but with no corresponding printed excerpt. They were instead instructed to use NRSV bibles.

This portion of the exercise again ended with a 15-minute discussion of findings.

The exercise concluded with an ad hoc discussion—led by the client—of a full-size reproduction of the medieval Peutinger map of the Roman Empire that the author had assembled and printed at the extraordinary full size of 22 ft. x 1 ft. (EurAtlas-Info, 2008).

3.1.4. Results

The student exercise of the Initial Proof of Concept SILAS, indeed, proved the basic concept that undergraduate religious studies students could

- Understand GIS concepts such as map scale and layers
- Construct their own maps using data layers of their choosing
- Annotate a map with scripture citations while reading from either prepared excerpts or a book of Hebrew and Christian Scripture
- Develop sophisticated insights about the text that might not be achieved at the undergraduate level without use of the Proof of Concept system.

The photograph in Figure 6 shows a student reading the text, assembling layers and annotating the transparencies during the course of the exercise.

Figure 6. Students participate in Initial Proof of Concept exercise

Despite the ease with which the Appendix A excerpts from the Matthew gospel accelerated the process of identifying places, students expressed a preference for reading directly from a Bible. This somewhat surprising result might be due to a perception that the highlighted text overly simplified the critical reading that was a central aspect of their coursework.

The students were instructed to make annotations—that is, chapter and verse references—to the places mentioned in the text. Most participants simply performed that task by writing citations in the standard form “Matt 11:22.” One group added arrows indicating the apparent direction of travel and distinguished between places that are mentioned versus places that are visited.

Figure 7 is one student’s annotation of the “Matthew” layer that uses a color code: blue and green to represent places that are mentioned and places that are visited, respectively. Note the student’s distinction in the colors used in Figure 7 for the following two citations that mention Capernaum:

“And you, Capernaum, will you be exalted to heaven?”
(Matthew 11:23)

“When they reached Capernaum, the collectors of the temple tax came to Peter and said, ‘Does your teacher not pay the temple tax?’”
(Matthew 17:24)

The student makes the important distinction that while Capernaum is mentioned in Matthew 11:23, the narrative of Matthew 17:24 actually occurs there.

Figure 7. Student color-coded annotation on Matthew layer with detail indicating annotation and color key.

Another significant finding was that the activity of reading coupled with map annotation revealed a question about the sequence of identical events described in both the Mark and Matthew gospels.

In Mark, Jesus' travels take him from Gennesaret on the Sea of Galilee (Mark 6:53-55) to the "region of Tyre" (Mark 7:24-29) and then back to the Sea of Galilee "by way of Sidon" (Mark 7:31). This journey takes the traveler perhaps 40 miles out of his way over mountainous terrain to return to the Sea of Galilee.

In Matthew, Jesus travels from Gennesaret (Matthew 14:34-15:20) to the "district of Tyre and Sidon" (Matthew 15:21-28) and then back to the Sea of Galilee (Matthew 15:29-38).

One of the students observed that this recounting of events in Matthew seems to smooth over the geographical problems of the same sequence in Mark. The ensuing discussion highlighted several questions at a level of sophistication that is not common at the undergraduate level:

- Is the author of the Mark gospel familiar with the geography of which he writes?
- Did the author of Matthew correct geographical problems in Mark because of his own first-hand knowledge of the region? Because of his intended audience?
- How do scholars make decisions about where ancient texts are written?

Students seemed to appreciate the overlay of southern California because it gave them a familiar reference by which to judge the extent of what is, for most, an otherwise unfamiliar part of the world.

At the conclusion of the exercise, the brief discussion of the massive Peutinger Map facsimile generated a discussion about purpose and agenda driving cartographic choices in ancient maps. Questions posed included 1) why are Rome and Jerusalem portrayed as they are, and 2) what does this say about the time period and influence of Christianity on the mapmaker? This discussion suggested that including historic maps in SILAS someday could generate valuable insights.

This exercise suggested the need for the following additional capabilities in a future version of SILAS:

- Ability to annotate the sequence of visits to places in a passage (using arrows, lines, etc.).
- Ability to differently symbolize places visited and places merely mentioned.
- Ability to incorporate historical map portrayals of the region, such as the Peutinger Map.

3.2. User Interface Mock-up

One of the most critical design aspects of SILAS is usability and the human-computer interface. The Initial Proof of Concept exercise showed that students can draw insight from easy to use geographic content, but will they use a computer interface that might be challenging to learn? The user interface mock-up was intended to address this concern early in the project before a single line of computer code was written. It had the unexpected benefit of starting a conversation that helped influence the scope and architecture of the project.

3.2.1. Concept Development

Many software applications use the familiar “wizard” interface to walk a user through a complex computer task. What would a SILAS wizard need to do to enable a student to create a map? Is that appropriate given the available GIS tools?

At this point in the development of SILAS, a basic architecture began to emerge: the student would use ArcMap with custom tools as well as a separate custom Windows application with a familiar wizard interface to create maps. This architecture would later be modified because of 1) the complexities of creating a Windows application and 2) the subsequent skills acquired by the author in using ArcGIS web application tools.

3.2.1.1. Use Cases

The following six use cases that describe typical activities performed by the student user were considered in developing the user interface mock-up:

- 1) Create a base map with pre-made and symbolized data layers for display on the screen.
- 2) Modify a base map to display specific features in a layer based on user-controlled characteristics.
- 3) Add annotations (notes, URLs, markers) to a previously created map or to features on the map.
- 4) Print a map.
- 5) Modify a base map by applying different pre-made symbology templates (optional).
- 6) Use a measuring tool to measure and save routes (optional).

3.2.1.2. ArcMap Tool Customization

ArcMap out-of-the-box can be extensively customized to remove and add tools, delete and add menu items and change what happens with the user right-clicks the mouse. These features informed the creation of the ArcMap menu bar mock-up of Figure 8 that was created with Adobe Photoshop.

Figure 8. ArcMap custom menu mock-up.

The commands of Figure 8 would provide the following functions:

- File: Typical file functions such as Open, Close, Save, Save As...
- Modify: Used to modify (or edit) a feature or layer on the map.
- Add: Used to add a new feature or layer to the map
- Style: Used to apply a style template (look and feel of the map)
- Print: To print a map with legend, scale bar and marginalia
- Help: Provide access to the help files.

These commands ostensibly satisfy the requirements of use cases 3, 4 and 5 while the familiar ArcMap navigation tools in Figure 9 (with the measure tool circled) address case 6.

Figure 9. Standard ArcMap tool bar highlighting measurement tool.

3.2.1.3. Wizard-style Windows Application

The more complex use cases that involve creating the initial map and then deciding which layers and data to display were left to a separate wizard-like Windows application which was also conceptualized in Photoshop.

For use case 1—creating a map and selecting the content—Figure 10 depicts the opening screen of the wizard while Figure 11 shows a dialogue box to select the layers to be included. This method would allow maximum flexibility for the student in deciding what data to include, which books of scripture to cover and, optionally, whether or not to create the map from one of three ready-made templates.

Figure 10. Opening wizard screen for creating a new map (use case 1).

Figure 11. Second wizard screen to select layers to display or choose a template for a new map (use case 1).

Figures 12 and 13 provide the first two wizard screens for adding a custom map layer to an existing map. This wizard was intended to give the student an unrestrained tool to decide how to label a layer, whether to include URLs, what cities and regions to include,

and which notes, if any, to display. It essentially exposes the complex functionality of the ArcMap “Layer...Properties” window to the student in a simplified interface.

Figure 12. Opening wizard screen for creating a new map layer or modifying an existing one (use case 2).

Figure 13. Second wizard screen to select what data to appear in a new map layer.

3.2.2. Design Critique and Results

A critique of these mock-ups by the project advisor, client and members of the University of Redlands GIS faculty was generally favorable, but the extent to which such a complex Windows application could be created and successfully integrated into the ArcMap architecture within the time constraints of this project was questioned. It would later

prove such a challenge to provide students with basic map editing tools that the wizard concept was discarded.

Creating these mock-ups was invaluable in starting a conversation among the client, advisor and author about what was possible and where to proceed next with the development of SILAS. The mock-ups of the ArcMap interface would later prove useful in developing the pre-prototype system described in section 3.6.

3.3. System Architecture Exploration

The extensive suite of ESRI's ArcGIS products provides a large number of architecture choices for a GIS system. Certainly a well-trained GIS operator with access to ArcMap and ArcCatalog could make short work of creating a map using pre-processed historical and text data already in digital format (along with the careful application of cartographic principles). The users of SILAS, however, will be students of religious studies who do not have weeks or months to spend learning how to use a conventional GIS.

The University of Redlands is fortunate in that all of the institution's computers on campus have GIS software—namely ArcMap 9.2—already installed. While tempting to use as a solution for SILAS, the complex interface of ArcMap is not an ideal solution. One of the requirements of this project was that a student with no GIS or cartographic experience be able to start making maps in less than one hour, an unlikely outcome for a novice user.

ArcGIS Engine, which is a fully customizable application development platform that runs on top of ArcMap, was a more attractive option, but it has a steep learning curve for the developer. The ESRI software suite also includes some free applications, as well as software with the ability to create web-based maps that require no investment in software on the client side. These no-cost options would make it convenient for students to work on SILAS at home using their own personal computers.

An exploration of these architecture alternatives is an essential part of this major individual project.

3.3.1. ArcGIS 9.2: The Baseline System

ESRI, Inc., (ESRI, 2008b) marketing material states:

ArcGIS is a complete system for authoring, serving, and using geographic information. It is an integrated collection of GIS software products for building and deploying a complete GIS wherever it is needed—on desktops, servers, or custom applications; over the Web; or in the field.

It is doubtful that this is mere hyperbole.

The MS GIS curriculum at the University of Redlands includes many weeks of training on what is arguably the most widely used and capable suite of GIS software ever created: ESRI's ArcGIS. This training and corresponding employment of the ArcGIS Desktop

portion (ArcMap and ArcCatalog) of the suite in many of the MS GIS program's course offerings made it the obvious choice to begin assembling data, creating maps, performing analyses, and authoring geospatial content in support of SILAS.

The MS GIS programs' compulsory 160 hours of training using the ArcGIS suite made it the preferred candidate for meeting the requirements of SILAS. But the need for all the training also made it a less attractive solution: the ultimate system must meet the needs of students who do not have weeks to spare for learning software.

Fortunately, ArcGIS counts among its many component applications customizable deployment mechanisms that can meet the requirements of the SILAS client system without an unnecessarily steep learning curve.

3.3.2. Free Software: ArcExplorer Web, ArcExplorer Java Edition for Education and ArcGIS Explorer

Though the University of Redlands can boast an installation of ArcMap and ArcCatalog on nearly all of its computer workstations, the complexities of the software and its absence from most students' personal computers dictated a look at some free alternatives that are part of the ArcGIS suite.

ArcExplorer Web and ArcExplorer Java Edition for Education are similar in that they can both display ArcWeb map services as layers and allow users to create and print maps. The Java Edition allows the user to also display ArcIMS services and create limited symbology for data. Neither has the ability to edit geospatial data or meet requirements 17-19 of Table 1 that pertain to map creation and annotation.

Another option was ArcGIS Explorer: a light standalone client application not unlike Google Earth. It can display web-based ArcGIS services and allows the user to add descriptive points. Unfortunately, the system's "pushpin" approach to mapmaking has very limited symbology and does not permit editing of geospatial data. Ancient places, for instance, cannot be easily added to the display without first looking up coordinates and then manually placing a marker. Appendix B contains a detailed comparison of these "GIS tools available for education" taken from the ESRI web site (ESRI, 2007c).

3.3.3. ArcMap 9.2

This professional-grade GIS application is a heavy desktop application that allows full editing of data in a large number of file formats. It can be used to conduct advanced spatial analyses, has "vast and unlimited classes and symbols" and, perhaps, vast and unlimited complexity for the user.

The ability of ArcMap to be customized extensively was an important factor in the system architecture exploration. The user interface could be greatly simplified by eliminating many of the advanced tools that have no place in SILAS. The software can be further customized via Visual Basic for Applications to create specialized toolbars with common tools (such as "print" or "measure") in one place.

ArcMap does not address the desirable characteristic that students be able to run the software on their personal computers, but it formed the core of the pre-prototype SILAS (described in paragraph 3.6) that students successfully used to create and print maps of places mentioned in the four gospels.

3.3.4. ArcGIS Engine 9.2

ArcGIS Engine provides a development environment and toolset that permit customization using ArcObjects, standard Visual Basic for Applications and/or ASP.NET computer languages. ArcObjects is a library of thousands of software components that make up the foundation of the ArcGIS suite, including ArcMap (see Figure 14).

Figure 14. ArcObjects form the building blocks for a variety of ArcGIS products. (ESRI, 2008b)

The degree to which ArcGIS Engine can be used to create a custom GIS application is extraordinary. In the hands of an experienced software developer, it can be used to create *any* function in ArcMap with *any* desired user interface employing *any* options or additional capabilities one can imagine on a modern desktop computer.

The downside is that ArcGIS Engine still requires that the user have an ArcGIS license and, despite having some user friendly tools for a software developer, the learning curve for developing with Engine is steep.

The author took 48 hours worth of training at ESRI in “Introduction to Programming ArcObjects using VBA” and “Extending ArcGIS Desktop Applications” as a foundation for programming in ArcEngine. This allowed him to create a few basic tools beyond the “cookbook-style” exercises contained in the ESRI course material—but did not even begin to explore the complexities of using Engine (covered by yet another course that was not available in time to support this project).

The complicated nature of developing GIS applications within the ArcGIS architecture is not solely the fault of ESRI. The company should be applauded for opening up their computer code (the ArcObjects) and providing training for creating applications. In the hands of a software developer with years of experience in the C-sharp and ASP.NET programming environments, this training would enable him or her to create sophisticated GIS applications well beyond the complexity of SILAS. Unfortunately, the time frame of SILAS did not permit using Engine to develop the application.

3.3.5. ArcGIS Server

The University of Redlands gives all MS GIS students ready access to ArcGIS Server technology. This was critical to the ultimate success of SILAS.

ArcGIS Server permits geodatabases and maps created with ArcMap to be deployed over the Internet. These maps can be displayed and edited with a variety of client applications, saved on either the server or the client's computer, and printed. ArcMap alone can do much of this, but it requires that all the geospatial data reside on the client's computer. This was not possible at the University of Redlands at the time of this project because the shared workstations are wiped clean of files every night. The undergraduate students were also not routinely granted access to a network drive. In either case, using ArcMap as the client application would necessitate the inconvenience of requiring students to do all of their mapping work on University of Redlands common workstations.

ArcGIS Server permits maps and geodatabases to be served as:

- Web Mapping Applications that use a web browser to view and edit
- Web Services that can be consumed with ArcMap, ArcExplorer, ArcGIS Engine custom applications, Google Earth or other applications
- Spatial Datadatabase Engine services (ArcSDE) that can be viewed and edited by a variety of applications
- Mobile Services for handheld mobile devices

3.3.6. Scripture Search Using ASP.NET and Microsoft SQL Server

The ArcGIS components discussed above address the visualization and spatial aspects of SILAS. But what about the text itself? The New Revised Standard Version of Christian and Hebrew Scripture consists of more than 30,000 verses and nearly 800,000 words. Fortunately, querying and displaying this amount of text data using a web browser can be accomplished with ASP.NET and Microsoft SQL Server technology which is easily accessible at the University of Redlands.

The author's extensive experience in creating web-accessible database applications along with ArcMap's built-in hyperlink functionality made it a straightforward task to enable users "to quickly identify the scripture verses that contain references to a particular place" (Table 1).

The problem of getting the text into SQL database was solved when the author exported the text from the BibleWorks 7 software installed on a number of the computers at the University of Redlands (BibleWorks, 2008). This text file was then loaded into a Microsoft Access database and exported to SQL.

The NRSV text used by the scripture search portion of SILAS is copyrighted by the National Council of Churches of Christ, but may be quoted or reprinted without express written permission with this caveat:

The [New] Revised Standard Version Bible may be quoted and/or reprinted up to and inclusive of five hundred (500) verses without express written permission of the publisher, provided the verses quoted do not amount to a complete book of the Bible or account for fifty percent (50%) of the total work in which they are quoted.
(National Council of the Churches of Christ, 2008)

SILAS was designed to honor this copyright by returning no more than 500 verses for any place mentioned in the NRSV. This limit is not exceeded by any place mentioned in the four gospels and is only exceeded in a few instances when the entire NRSV is searched (e.g., Israel, Judah, Egypt and Jerusalem).

3.4. System Architecture Candidate Designs

The architecture exploration undertaken in section 3.3 led to three system design candidates, all of which could meet the mandatory requirements in Tables 1 and 2. All three of these designs could be ultimately be implemented with the components delivered with the final version of SILAS, but only Option 3 (paragraph 3.4.3) would meet the requirement for an easy-to-learn interface that is accessible using a student's own personal computer.

3.4.1. Option 1: Standalone ArcMap 9.2

The standalone ArcMap architecture depicted in Figure 15 would be the simplest option to implement since it contains no server component.

Figure 15. Option 1, ArcMap 9.2 architecture.

It requires a basic map file (ArcMap mxd) and geodatabase loaded on a thumb drive, network drive or other external source. It also needs ArcMap 9.2, which is already installed on University of Redlands workstations. This configuration is essentially the same as the pre-prototype SILAS ArcMap system that was evaluated with the assistance of student volunteers (see paragraph 3.6). The only difference is that Option 1 does not include the scripture search feature which would require a web server. The main drawback of this architecture is that ArcMap has a rather steep learning curve. Taken with the inconvenience of students having to use a University of Redlands computer with a thumb drive or network storage, this solution would pose significant operational challenges.

3.4.2. Option 2: ArcMap 9.2 with ArcGIS Server

The combination of ArcMap as the client software with all of the data being stored on a server that is conveniently accessible via the network solves some of the shortcomings of Option 1. The external thumb drive or network storage of Option 1 is replaced by the “MSGIS-01” enterprise server with ArcGIS Server (with SDE), Microsoft Internet information Server (IIS) with ASP.NET and Microsoft SQL Server (see Figure 16). SILAS used the “MSGIS-01” virtual server which was configured by the Redlands Institute staff to run ArcGIS server, SQL Server and ArcSDE. The structure of the data is discussed more fully in paragraph 3.5, but the main characteristics are as follows:

- A non-editable map background service (hillshade, physical features, major boundaries and region labels)
- An editable ArcSDE layer that the student will use to add notes and scripture references
- ArcSDE layers of user-selectable data that contain roads and labels for large scale map views

- A non-geospatial database of the NRSV text with ASP.NET software code for the scripture search feature.

The challenges of Option 1, namely the steep learning curve for ArcMap and the continued need to use a University of Redlands computer for creating a map, remain with Option 2.

Figure 16. Option 2, ArcMap 9.2 with ArcGIS Server architecture.

3.4.3. Option 3: Web Mapping Application with ArcGIS Server

The final architecture configuration considered for this project uses ArcGIS Server similar to Option 2, but exploit the full capability of ASP.NET with a web mapping application that requires only a web browser (see Figure 17). ArcGIS Server has components to utilize the Microsoft Visual Studio integrated development environment (IDE) and ESRI’s Web Application Development Framework (ADF) for quickly creating web mapping applications. The drag-and-drop simplicity of the IDE is at first quite attractive and easy to use, but the developer soon learned that detailed configuration of the web page components is quirky and dependent on a myriad of specific settings to enable the editing that SILAS requires. The specifics of this configuration—which is essentially the deliverable, final version of SILAS—are described in paragraph 3.7.

Figure 17. Option 3, web mapping application with ArcGIS Server architecture.

3.4.4. Assessment of System Architecture Design Candidates

The three options considered for the final architecture design for SILAS all stand up well against the 29 requirements for the system (see Table 1. Functional Requirements and Table 2. Non-Functional Requirements). The Table 5 “Requirements Evaluation Matrix” is a summary of the degree to which each option meets the system requirements.

Table 5. Requirements Evaluation Matrix

Number	Description	Priority	Option 1	Option 2	Option 3
<i>Perform the following overall functions:</i>					
1	Shall permit the mapping of all places mentioned in the four Gospels in the Bible without having to look up coordinates (Matthew, Mark, Luke and John)	1	●	●	●
2	Shall use the “New Revised Standard Version” of Bible	1	●	●	●
3	Shall have an extent equal to or greater than that of the Roman Empire from 0 C.E. to 200 C.E.	1	●	●	●
4	Shall include data representing the time period 0 C.E. to 200 C.E.	1	●	●	●
5	The user shall have be able to save and print maps	1	●	●	●
<i>Perform operations on data as follows:</i>					
6	The user shall be able to display an overlay of Roman roads	1	●	●	●
7	The user shall be able to display a base map of physical geography (terrain, hydrography, shorelines)	1	●	●	●
8	The user shall be able to display populated places	1	●	●	●
9	The user shall be able to display Roman empire boundaries and divisions	1	●	●	●
10	The user shall be able to quickly identify the scripture verses that contain references to a particular place	2	NO	●	●
11	The user should be able to display an overlay of Trade Routes	2	○	○	○
12	The user should be able to display an overlay of the Jewish diasporic communities	2	○	○	○
13	The user shall be able to display historical events	3	○	○	○
14	The user may be able to display population distribution	3	○	○	○
15	The user may be able to display overlays of historical maps	3	○	○	○
16	The user may be able to display overlays of climate data	3	○	○	○
<i>Create and annotate maps as follows:</i>					
17	The user shall be able to select which layers to display.	1	●	●	●
18	The user shall be able to add/modify/delete labels	1	●	●	●
19	The user shall be able to add/modify/delete annotations	1	●	●	●
20	The user should be able to create annotations that include images	2	●	●	●
21	The user should be able to choose symbology	2	●	●	NO
22	An undergraduate humanities student with computer experience but no experience in maps or cartography shall be able to create and print a map independently after no more than 30 minutes of classroom instruction or after no more than 60 minutes of self-guided instruction.	1	NO	NO	●
23	The system shall utilize client software that is either free or already available on computers at the University of Redlands.	1	●	●	●
24	The system shall be documented so that it can be maintained and extended to other texts and applications.	1	●	●	●
25	The system shall include electronic versions of both user help and a tutorial for student operation.	1	●	●	●
26	The system shall allow up to 5 concurrent users	1	●	●	●
27	The system should be able to run on student’s personal computers without the purchase of additional software	2	NO	NO	●
28	The user interface should include a Wizard-like interface to take the student through the map creation process with visual feedback as selections are made.	2	NO	NO	NO
29	The system should allow up to 20 concurrent users	2	N/A	?	?

● - meets requirement ○ - meets requirement if data available ? - depends on server

Priority: 1 - Mandatory, 2 - Desirable, 3 - Optional

All three options meet nearly every requirement, be it mandatory, desirable or optional. No option meets the requirement to display trade routes, Jewish diasporic communities, historical events, population distribution, historical maps and climate data. This is not due to any constraints in the chosen architectures, but due to the lack of available georeferenced data prior to the completion of the project. Since this data will most likely not already be in a format that SILAS can use, a future effort by a GIS student to digitize paper sources of this data is indicated. Portions of the task could be undertaken by religious studies students, but either some training in georeferencing or a new version of SILAS that allows the user to add polygon, line and point data is required.

The few instances where the architectures differ are in the areas of usability and the availability of the scripture search feature.

The requirement that “the user shall be able to quickly identify the scripture verses that contain references to a particular place” is not met by Option 1 since it does not have the server component with the searchable NRSV text database. Other desirable requirements that are not met include the ability for the system to run on a student’s personal computer (not met by Options 1 and 2) and the inability of the user to select their own symbology with the web application.

A further desired ability is to permit up to 20 concurrent users on the system. This is not applicable to the standalone ArcMap option, but posed a challenge for the other server-based designs. The limitation is related to the server hardware. In a test of Option 3 with eight concurrent users, there was no problem so long as the users were editing their own content (see paragraph 3.7).

None of the three options meets the desire to have a wizard-like interface to guide the student through the map creation process. The complexities of programming such a Windows application that integrates with ArcMap prevented this from being an achievable goal (see paragraph 3.2.2).

The only mandatory requirement that two of the Options fail to meet is as follows:

22. An undergraduate humanities student with computer experience but no experience in maps or cartography shall be able to create and print a map independently after no more than 30 minutes of classroom instruction or after no more than 60 minutes of self-guided instruction. (Table 5)

Neither ArcMap solution (Options 1 and 2) meets this requirement. The problem lies with the complexity of editing in ArcMap. This complexity is implicitly acknowledged by ESRI because is not included in introductory ArcMap training which itself requires 24 hours of classroom instruction.

Unlike most computer applications such as word processors and image editing programs, editing in ArcMap has two aspects: spatial and attribute. Editing can only begin after an editing session is started for a particular layer and if that layer is chosen as “selectable.” A cartographic marker at a particular location, for example, cannot be selected and moved unless the layer in which it resides is “selectable.” Furthermore, such a marker

has an entry in an attribute table that can be edited like a spreadsheet, but the symbology for that marker comes from a layer style with query parameters—a totally separate way to alter the appearance of a symbol. Upon completion of editing, the user must also first stop the editing session and then save edits. An experienced GIS professional who needs to keep track of editing sessions—as they separate navigating the content from editing—gains efficiencies and improved capabilities from such a system, but it can be confusing for others.

Customizing the ArcMap interface to simplify editing may be worth the effort, but presents challenges. Keeping track of both the “state” of the user’s ArcMap session and controlling the software housekeeping functions that ensure the integrity of edits is not trivial even for an experienced developer. Customizing the edit function is not even addressed until the final day of 24 hours of classroom instruction in the ESRI courses “Introduction to Programming ArcObjects Using VBA” (ESRI, 2007d) and “Extending the ArcGIS Desktop Applications” (ESRI, 2006).

Editing is much simpler using the web “Editor” task that is easily added using ArcGIS Visual Studio IDE. This architecture for SILAS—Option 3—is the version that was ultimately delivered.

3.5. Geodatabase Design and Data Structure

SILAS used an ArcCatalog-created file geodatabase, some stand-alone imagery files to create the background hillshade, a SQL database of NRSV bible verses and several ArcSDE databases. The fields contained in all of the database files are described in Table 6 while more details about the characteristics and origins of this data are contained in Appendix C.

Table 6. SILAS Data Components

Feature	Description and Origin	Attributes	Spatial Representation
Boundaries	Boundaries of regions in the 1 st Century Palestine and the Roman Empire (Attridge & Meeks, 2006)	ID, Name, Type (Herod's Kingdom, Roman Empire or Region)	Polyline
Large_Labels	Annotation for major Roman provinces and regions (Attridge & Meeks, 2006; ESRI, 2007b; Getty Research Institute, 2007)	n/a	Annotation
Palestine_Labels	Annotations labeling political regions when zoomed into area of Judea and Samaria (Attridge & Meeks, 2006)	n/a	Annotation
Countries	ESRI World Countries 2007 File Geodatabase, Redlands Institute, \\ri-fps\RI\GIS\ESRI\Data\Data&Maps_2007Update\world\data\cntry07.sdc (ESRI, 2007b)	ID, Name, and many more (ESRI, 2007b)	Polygon
Bodies_of_Water	Inland water and world shoreline features clipped to Roman Empire. (National Geophysical Data Center (NGDC), 2008)	ID	Polygon
Rivers	ESRI World Rivers Feature Database, Redlands Institute, \\ri-fps\ESRI\Data And Maps\world\data\rivers.sdc (ESRI, 2007b)	ID, Name	Polyline
Ancient_Places	ESRI World Cities Feature Database, Redlands Institute, \\ri-fps\ESRI\Data And Maps\world\data\cities.sdc (Attridge & Meeks, 2006; ESRI, 2007b; Getty Research Institute, 2007)	ID, Name, Type (City, Region, Peak, Other), Matthew, Mark, Luke, John, GospelFlag, Notes	Point
RE_PopPlaces	ESRI World Gazetteer Feature Database, Redlands Institute, \\ri-fps\ESRI\Data And Maps\world\data\gaz.sdc (ESRI, 2007b)	ID, Name, and many more (ESRI, 2007b)	Point
RomanRoads	Hand-digitized Roman Roads in the region of Palestine from the Barrington Atlas of the Greek and Roman World (Talbert & Bagnall, 2000)	ID, Type (Major, Minor, Major approx., Minor approx.)	Polyline

Table 6. SILAS Data Components (continued)

Feature	Description and Origin	Attributes	Spatial Representation
africa_150m_earthsat.jp2	Africa (150m) – EarthSat NaturalVue Global Landsat Mosaic, from Redlands Institute, \\ri-fps\ESRI\Data And Maps\GlobalImagery\GlobalImagery_EuroAfrica\global_imagery\afrika_150m_earthsat.jp2 (ESRI, 2007b)	3 Bands	Raster
europa_150m_earthsat.jp2	Europe (150m) – EarthSat NaturalVue Global Landsat Mosaic, from Redlands Institute, \\ri-fps\ESRI\Data And Maps\GlobalImagery\GlobalImagery_EuroAfrica\global_imagery\europa_150m_earthsat.jp2 (ESRI, 2007b)	3 Bands	Raster
srtm_n_relief_c.jp2	SRTM Shaded Relief, from Redlands Institute, \\ri-fps\ESRI\Data And Maps\GlobalImagery\GlobalImagery_EuroAfrica\shaded_relief\srtm_n_relief_c.jp2 (ESRI, 2007b)	1 Band	Raster
dbo.NRSV_Bible	Extracted from Bible Software on University of Redlands workstations.	ID, Book, Book_Chap_Verse, Chapter, Verse, VerseText	Table
Cities_Examples and AP_Student_1 through 8	ESRI World Cities Feature Database, Redlands Institute, with Getty Thesaurus and Harper Collins Study Bible, path to base data \\ri-fps\ESRI\Data And Maps\world\data\cities.sdc (Attridge & Meeks, 2006; ESRI, 2007b; Getty Research Institute, 2007)	ID, Name, Type (City, Region, Peak, Other), Matthew, Mark, Luke, John, GospelFlag, Notes	Point

The extent of all the geospatial data content has been clipped to a rectangle of nearly 20 million square kilometers that encompasses all of the 1st century Roman Empire with the exception of a small portion around the British Isles (see Figure 18). All geospatial data, with the exception of the rasters used to create the hillshade, were reprojected into a coordinated system centered on Rome and based on the Albers Conic Equal Area Projection. The “Albers Conic Equal Area Roman Empire Projection” has the following characteristics:

Standard Parallels: 30° N and 45° N

Central Meridian: 15° E

False Northing: -4454806 m, False Easting: 205724 m

Center: Rome, Italy

Linear Unit: meter

Figure 18. Extent of SILAS, modified Albers Conic Equal Area Projection.

This compromise projection does not distort the direction of north in the area of Palestine as much as an equidistant projection such as the European Conic Equidistant Projection. The Albers equal area projection only represents distances correctly along the standard parallels, but extremely accurate distance measurement in all parts of the map is not a client requirement. The rather odd choices for false northing and easting put Rome at the center of the coordinate system, making it easy to ascertain x-y distances to the political center of the Roman Empire.

3.5.1. File Geodatabase

The structure of the file geodatabase, called “SILAS_J1.gdb” in Figure 19, includes four feature datasets: “Administrative,” “PhysicalFeatures,” “Places,” and “Transportation.”

Figure 19. Structure of SILAS_J1 file geodatabase, raster imagery and Bible text database.

The “Administrative” feature dataset contains shapefiles of modern country boundaries (ESRI, 2007b) and regional boundaries (including the boundary of the Roman Empire) (Attridge & Meeks, 2006). It also includes some cartographic labeling for both the entire Roman Empire (“Large_Labels”) and for the region of 1st century Palestine (“Palestine_Labels”).

The “Physical Features” feature dataset contains feature classes for bodies of water (oceans seas as well as inland lakes) and rivers (ESRI, 2007b).

“Places” contains a feature class “AncientPlaces” that includes 40 cities, towns, regions and mountain peaks that are mentioned in the four gospels as well as 64 other important places named in maps included in the Harper Collins Study Bible (Attridge & Meeks, 2006). There is also a feature class called ‘RE_PopPlaces’ that contains over 12,000 modern populated places within the extent of Roman Empire that were clipped from “ESRI Data & Maps 2007 World, Europe, United States, Canada and Mexico” (ESRI, 2007b).

The “Transportation” feature dataset contains “RomanRoads” in the area of Palestine digitized at the 1:500,000 scale from maps in the Barrington Atlas of the Greek and Roman World (Talbert & Bagnall, 2000).

3.5.2. Raster Datasets for Hillshade

Raster data can result in huge files sizes—especially if the geographic area is large as it is in SILAS.

The three files that comprise the background hillshade mapping service, as shown in the ArcCatalog structure of Figure 19, occupy over 3 Gbytes on the enterprise server.

All three JPEG2000 format files came from the “ESRI Data & Maps 2007 World, Europe, United States, Canada and Mexico” (ESRI, 2007b) data collection.

The two 150m EarthSat NaturalVue Global Landsat mosaics of Europe and Africa were combined with a 90m SRTM shaded relief image fused with other data to create a cached background web service that can be quickly loaded in ArcMap or a web browser.

3.5.3. SQL Database of NRSV Text

More than 31,000 verses of scripture in the NRSV text have been placed in a SQL table in a database called “Bible” in Figure 19. A table called “dbo.NRSV_Bible” inside “Bible” resides on the same enterprise server as the other data.

3.5.4. ArcSDE Databases

SILAS uses ArcSDE to hold 11 feature classes of spatial data and one annotation file in geodatabases as shown in Figure 20. Only data in an ArcSDE spatial database may be edited with an ArcGIS Server web mapping application. ArcSDE allows enterprise database assets to be managed more efficiently so that the spatial data can be quickly used by a variety of applications (including ArcMap and a web browser) (ESRI, 2007a).

Figure 20. ArcSDE databases used in SILAS.

“Ancient_Places,” “Palestine_Labels,” and “Roman Roads” are SDE versions of the same feature classes used in the file geodatabase. “Cities_Example” is a version of “Ancient_Places” with all 280 gospel references to places already entered while “AP_Student_1” through 8 are duplicates of “Ancient_Places” with versioned editing turned on so up to eight students can edit and save their own map content.

3.6. Pre-prototype ArcMap System

The Option 1 ArcMap 9.2 version of SILAS is essentially the pre-prototype version that was evaluated by Dr. Larsen's religious studies students on March 19, 2008. It was intended to be a rudimentary ArcMap implementation of the manual, acetate and paper mapmaking process in the Initial Proof of Concept exercise.

The system consisted of MXD map files, a geodatabase similar to SILAS_J1.gdb in Figure 19, rasters for the background hillshade, and the SILAS scripture search feature on the MSGIS-01 virtual server.

3.6.1. Geospatial Data

The geospatial data used for the pre-prototype version of SILAS came from many of the same sources as the file geodatabase described in paragraph 3.5.1, but with 58 places extracted so that each city is a separate shapefile and, in turn, a separate layer in the MXD file. The rather cumbersome process of creating these 58 shapefiles in the "Cities Singly" feature dataset in the SILAS_March_REJ geodatabase of Figure 21 serves to shield the student user from having to edit in ArcMap. They could simply turn on a map layer for an individual city to indicate in which of the four gospels it occurs.

Figure 21. SILAS_March_REJ.gdb Geodatabase Structure for Pre-prototype Exercise

Note that the “_REJ” and “_RE” suffixes in feature class names in the geodatabase denote they have been clipped to the Roman Empire and reprojected to the Albers Conic Roman Empire map projection. “_C” and “_Clip” likewise mean that the data has been clipped to the extent of the Roman Empire. Table 7 has further details on the data used in the pre-prototype.

Table 7. SILAS Pre-prototype Data Components

Feature	Description and Origin	Attributes	Spatial Representation
HolyL_Regions_REJ, RegBoundLines_REJ, RegionBorders, RomEmpBound_REJ	Boundaries of regions in the 1 st Century Palestine and the Roman Empire (Attridge & Meeks, 2006)	ID, Name, Type	Polyline
HolyL_Regions_lbl_REJ	Annotation for regions	n/a	Annotation
Abilene, Aenon, ... Zarepath	Individual shapefiles, one for each place mentioned in the four gospels (Attridge & Meeks, 2006; ESRI, 2007b; Getty Research Institute, 2007)	ID, Name, Type (City, Region, Peak, Other), Matthew, Mark, Luke, John)	Point
Cities_RE	Same as individual shapefiles for cities, but combined into one feature class.	ID, Name, Type (City, Region, Peak, Other), Matthew, Mark, Luke, John)	Point
Other_Cities	Reference cities in Roman Empire not mentioned in four gospels. (Attridge & Meeks, 2006; ESRI, 2007b; Getty Research Institute, 2007)	ID, Name, Type (City, Region, Peak, Other), Matthew, Mark, Luke, John)	Point
WorldCities and WorldCities_C	Major cities of the world; the “_C” version is clipped to Roman Empire (ESRI, 2007b)	ID, Name, and many more	Point
WorldPlaces and WorldPlaces_C	World gazetteer ; the “_C” version is clipped to Roman Empire (ESRI, 2007b)	ID, Name, and many more	Point
DrainIsrael	Not used	n/a	n/a
Lakes_C	Inland water features clipped to Roman Empire. (National Geophysical Data Center (NGDC), 2008)	ID, multiple	Polyline
Shoreline_C	World shoreline clipped to Roman Empire. (National Geophysical Data Center (NGDC), 2008)	ID, multiple	Point
RomanRoads_REJ	Hand-digitized Roman Roads in the region of Palestine from the Barrington Atlas of the Greek and Roman World (Talbert & Bagnall, 2000)	ID, Type (Major, Minor, Major approx., Minor approx.)	Polyline
IS_HillShd, RE_DEM_C, RE_HillShd_C, WaterDEM	Various hillshades and DEMs derived from SRTM data (Consultative Group on International Agriculture Research Consortium for Spatial Information (CGIAR-CSI), 2008)\	1 Band	Raster

3.6.2. Cartography and Visualization

One of the challenges of SILAS is to simultaneously display four different symbols for a single place that is mentioned in all four gospels. This was accomplished using a compound, offset symbol that combines letters and colors to represent the four gospels (see Figure 22).

Figure 22. Compound symbology used to represent places in pre-prototype exercise (enlarged).

This symbology is somewhat problematic since it is a bit small on a computer display and has a fair amount of white space due to the overlaying letters. It is also unfortunate that Mark and Matthew begin with the same letter, requiring either double-letter abbreviations or, in this case, the use of the unique letter “R” for Mark.

The ArcMap MXD file “SILAS_3.mxd” includes a pre-formatted layout for printing that will result in a map like Figure 23. This allows the student user to set aside the complication of adding cartographic elements such as the legend, scale bar, north arrow and map title. Unfortunately, in using the automatic placement of labeling and symbols in ArcMap, there can be significant crowding and loss of symbology depending on the zoom level. This could conceivably detract from students’ asking critical questions about ancient text and its geography. It is important for students to know that either changing the zoom level on a GIS or reducing the number of layers displayed can reveal geographic content that might be invisible due to the overlap of symbology that would otherwise make the display unreadable.

Figure 23. Map created from SILAS pre-prototype.

3.6.3. SILAS Scripture Search Web Application

The only major difference between the pre-prototype architecture and Option 1 is the addition of the scripture search feature. The ASP.NET web application for the search feature uses the “Name” field from the “Cities from Bible” layer to construct a URL that executes a database query and returns the results via a web page.

ArcMap allows the map designer to specify a hyperlink base (the option is under “File...Document Properties”) that it will append to a hyperlink field that is specified in the “Display” tab of a layer’s properties.

The hyperlink base for SILAS is:

<http://msgis-01.spatial.redlands.edu/SILAS2/search.aspx?place=>

When the hyperlink tool is selected, hotspots will appear as blue dots that when clicked will execute a web query of the form:

<http://msgis-01.spatial.redlands.edu/SILAS2/search.aspx?place=\Bethsaida>

Figure 24 shows how hyperlinks for Chorazin, Bethsaida and Capernaum are shown as blue dots (the hyperlink cursor circled in red).

Figure 24. Detail of pre-prototype map with hyperlink tool circled.

The output from the scripture search lists the books, chapters and verses that match the place name in the four gospels. The user can alternatively select “get all Bible matches” to get all the scripture matches or even enter a word of their choice in the search box. A screen shot of the scripture search results for Bethsaida is illustrated in Figure 25.

Figure 25. SILAS Scripture Search example for Bethsaida.

The query results are limited to 500 verses to meet the requirements of the NRSV copyright (National Council of the Churches of Christ, 2008).

3.6.4. ArcMap Development and Customization

The three ArcMap MXD files created for the pre-prototype were used in a four-part exercise that leads the student through the process of creating and printing a map. The layers of the MXD's are a variety of symbolizations of the content of the geodatabase with additional layers of modern countries and world atlas and satellite imagery services from ESRI's Geography Network and ArcGIS Online, respectively (ESRI, 2008d, 2008e).

The system also utilizes a set of custom tools not unlike those described in the user interface mock-up task. These tools include "My SILAS Map" which switches from data

view to layout view and a “Go To...” pull down menu that has bookmarks to major places of interest (Gallilee, Jerusalem, Israel, and Roman Empire). The bookmarks allow a student to reorient themselves to more familiar geography.

3.6.5. Student Hands-On Exercise

The March 19 hands-on exercise acquainted students with the SILAS ArcMap interface using workstations in Room 134 in Lewis Hall. Five students from Dr. Larsen’s Religious Studies classes used ArcMap 9.2, the three MXD files and a geodatabase that were all pre-loaded on the computers prior to the start of the exercise.

The students were instructed to log onto the computer systems using their usernames and passwords and then given a 12 page exercise hand out that began with the following introduction:

SILAS is a Geographic Information System (GIS)-based program that will allow you to create and print maps of readings, events and places mentioned in Hebrew and Christian Scripture. These maps should help in understanding the place or “spatial” context of the narratives and accounts given in Hebrew and Christian Scripture.

SILAS uses software called “ArcMap” that was created right here in Redlands by the ESRI corporation and which is available on most computer workstations at the Jones Computer Center and other places on campus. This exercise will consist of...

- EXERCISE 1: Introduce you to the ArcMap interface
- EXERCISE 2: Explore map content that has been created for SILAS
- EXERCISE 3: Learn how to modify the content and make a new map
- EXERCISE 4: Print your map.

(Benzek, 2008f)

The first exercise introduced the students to the interface and basic navigation functions of ArcMap: the table of contents (TOC), standard and “tools” toolbars, map display and main menu. The map scale indicator, the zoom, pan and full extent tools as well as the custom bookmark tool “Go To...” were explored. The students were introduced to the selectable layers in the TOC by first showing them how to display satellite imagery so familiar to Google Earth users. The students quickly learned basic ArcMap navigation tools and how to move around the map.

The next step acquainted the users with the content of the SILAS geodatabase displayed in carefully symbolized layers. Turning on point data layers such as “Cities from the Bible” and “Other Cities” was contrasted with the image data from the “Terrain” layer near the bottom of the table of contents. The students used the find tool (binocular icon) to locate a city and used the symbology “legend” in the TOC to understand the road subtypes in the Roman Roads layer.

Exercise step 3 required the students to use the NRSV text (i.e., their own copy of the Bible) to turn on individual city layers to symbolize places mentioned in the Luke gospel. The student did not modify the underlying data: they selectively turned on cities that are grouped under “Luke” in the TOC to change the symbology on the map. Hundreds of city layers in the TOC make it huge when the content is expanded, but groupings (i.e.,

“My Gospel Places”) and subgroupings (i.e., “Luke”) help make it manageable (see Figure 26).

Figure 26. Pre-prototype map document table of contents (partial view).

The students were also instructed on how to use the hyperlink tool to find scripture place references in the text in Exercise 3.

The final step in the exercise enabled the students to use the skills acquired in the previous steps to create their own map and print it with preformatted legend, scale bar, north arrow and title.

The exercise showed that these Religious Studies students—all but one having never used ArcMap before—could use a self-paced tutorial to create and print a map of scripture locations in 1st century Palestine in less than one hour. The students seemed to be stimulated by the combination of map creation and scripture reading in a way that either task taken separately might not achieve.

One student, for example, was motivated to locate the Greek island of Patmos that is briefly mentioned in Revelations 1:9. Using the “Find” tool to query the ESRI world atlas service, she successfully located the island, but was unable to place a marker there because it was not previously included in the pre-defined layers in the TOC.

3.7. Prototype (Deliverable) SILAS Web Application

The web mapping application described in “Figure 17. Option 3, web mapping application with ArcGIS Server architecture” is the chosen architecture for the Prototype (deliverable) SILAS system. The system meets all of the mandatory requirements for SILAS and satisfies most of the desirable and optional requirements as well. It brings together components of ArcGIS Server, ArcSDE, ArcMap, SQL server and ASP.NET in a way that provided superb learning opportunities for the author and resulted in a system that should form the basis for further refinements and ultimate incorporation into the Religious Studies curriculum.

3.7.1. Geospatial Data

The data used in the prototype is the same as described for Option 3 (see Table 6 and Appendix C).

3.7.2. Cartographic and Visualization

The challenge of displaying up to four markers at once for one location remains with this final version of SILAS. Further experience with cartography and consultation with MS GIS program faculty resulted in a different compound marker symbol as shown in Figure 27.

Figure 27. Compound symbology used to represent places in Prototype exercise (enlarged)

This diamond-shaped symbol has been compared by some to the hazardous cargo signs on the sides of semi-trailers. Any such resemblance is coincidental, and perhaps highlights the intelligent design of such a symbol.

The background of the map is a simple combination of the SRTM hillshade set to 20 percent transparency on top of the Landsat mosaics of Europe and Africa.

The requirement that the system display students’ notes as well as scripture annotations along with the gospel symbology can make for an extremely congested map. At many scales, symbols and labels will necessarily be omitted due to ArcGIS algorithms intended to deconflict overlapping labels. Selecting and printing a subset of layers and perhaps printing multiple maps can overcome this limitation.

It is instructive to compare the automatically drawn output from the SILAS web application with the carefully constructed treatment at the hands of a budding cartographer.

Figure 28 shows a composite of two screen captures from the prototype SILAS that has been fully populated with scripture references for all places mentioned in the four gospels. Compare this with the same data used in a manually constructed cartographic representation in Figure 29.

(Benzek, 2008d)

Figure 28. SILAS Map of 1st century Palestine, web application output composite.

(Benzek, 2008c)

Figure 29. SILAS map of 1st century Palestine, using ArcMap and Adobe Photoshop.

The obvious difference between the manual representation and the web map, besides the use of notes and insets, is the cartographic license employed in eliminating label and element collisions. Post-processing of the map in Adobe Photoshop to place a faded white halo or vignette around the compound markers that apply to a region label improves its readability. The maps are, nonetheless, quite similar and the web-generated map certainly is a cartographic improvement over the informative, yet rough hand drawn maps characteristic of previous classes of Religious Studies students (see Figure 1).

3.7.3. ArcMap Development and Preparation

The steps required to create a web application begin with preparing the data and creating a map document (.MXD file) that meets the requirements of SILAS and is optimized for publication as an ArcGIS service. The collection of SILAS data in the map documents is, in turn, published as a web service to be consumed by the SILAS web application (see Figure 30).

Figure 30. Components of background web service “J2_back.”

“J2_back,” or the map background service for SILAS, takes advantage of the “single fused cache” feature of ArcGIS Server which provides the fastest display performance. Tests of the system performance showed a 5-15 second delay after each zoom or pan action without the cache. Note that “J1” and “J2” are simply date codes for the author to indicate when a particular data component was created.

This comes at some cost in that the service cannot have individual layers turned off and zooming is limited to the following seven levels:

1:25,000,000
1:10,000,000
1:3,000,000
1:2,000,000
1:1,000,000
1:500,000
1:250,000

The process of creating the cache—which is over 3 GBytes—took nearly 36 hours. Now created, it can continue to be served without delay unless the underlying imagery or data layers are changed.

The foreground symbols and data in SILAS cannot be cached since they can be edited by the student users at any time. Decisions with regard to symbology, scale-dependent visibility, and the use of annotation rather than labels can affect the performance of a web service like this that is not cached. The foreground MXD also had to be customized with Visual Basic Script (VBscript) to create a text wrap for all notes and verse citations. Without this scripting, any note greater than a few words could continue as one line of text horizontally until it reached the entire width of the map.

Figure 31 shows the components of a foreground map service for a typical student's web application. One such database, map document and web service must be created for each student using the system.

Figure 31. Components of SILAS foreground editable map service

Note that there are multiple ArcSDE services for the foreground map service: one for each student user (sde.SDE.A__Student_1, _2, _3, etc.), one example database that has all the gospel citation data (sde.SDE.Cities_Example) and one blank master database to use to create additional student data (sde.SDE.Ancient_Places).

These web services can be viewed and/or edited in ArcMap, ArcGIS Explorer or ArcGIS Engine.

Combining the shared background service with one of the foreground services in a web page to permit navigation, finding places, searching text and editing content is left to the web application.

3.7.4. Web Application Software Development

To create the final web application for SILAS, the out-of-the-box web application components that ESRI provides must be customized and configured using a variety of tools including Microsoft Visual Studio (a tool to author computer code for ASP.NET technology) and Adobe Photoshop to create graphics for the web application and the on-line tutorial and help.

The components of the SILAS map web application are identified in the screen shot of Figure 32.

Figure 32. Screen shot of SILAS web application showing Menu/Toolbar, Console and Map components.

It is generally straightforward to create a web application using the integrated development environment of Visual Studio. One need only specify the map services to

consume, ensure file and service permissions are set correctly, and deploy the web application on a Microsoft Internet Information Server.

Nonetheless, a significant amount of customization is required to implement these four features:

1. The hyperlink tool to perform queries of the NRSV text when a place is clicked
2. The editing feature to permit students to add scripture verse references and notes.
3. Customized graphics and integrated on-line help.
4. The ability to print a map.

For complete details on this customization, see the journal prepared by the author for the MS GIS course “Web Mapping Applications” in Appendix E.

The hyperlink tool was downloaded from ESRI and installed per directions on the web site (Brenneman, 2007). Unfortunately, the subsequent installation of service pack 4 on the MSGIS-01 web server caused the tool to stop functioning. The solution was for ESRI to re-compile the hyperlink software to work with SP4. The rapidly changing software environment predicts that this tool will yet again be superseded by the release of ArcGIS 9.3 in Summer, 2008.

The editing feature is a drag-and-drop component in the Visual Studio IDE, but there are some poorly documented critical steps necessary to get it working (see Appendix E). The successfully configured editor appears in the web application under “Tasks.”

The ESRI web application standard help was customized to reflect the look and feel of SILAS and to document all of the features of the application. Adobe Photoshop and Visual Studio were used to create the HTML documents and to create the custom graphics, header and color palette of SILAS. The student user can access both the help files and a tutorial by using the corresponding links at the top of the web page.

Finally, the tool to print a map was downloaded and installed from the ESRI Web Application Documentation Library (ESRI, 2008c). The installation of this task was straightforward but required careful attention to the installation instructions that involve multiple components of ArcGIS Server.

The development of the web application was fraught with difficulties due to tiny details often overlooked within the documentation (such as defining a map service as “local” in Visual Studio if you want to enable editing) and the prevalence of a few bugs in the software. On numerous occasions, useful and timely help from Dr. Bryan Baker, an adjunct instructor in the MS GIS program and ESRI manager, saved the web application from near failure.

3.7.5. Student Hands-On Exercise

The SILAS Prototype web application was evaluated in an exercise on June 10, 2008 with four Religious Studies students, the project advisor Dr. Diana Sinton, the client Dr. Lillian Larsen, and Ruth Costley and Theresa Ellis of the University of Redlands. The

participants used computer workstations in Room 134 in Lewis Hall, but could have just as easily used any computer with a web browser connected to the University of Redlands network (see Figure 33).

Figure 33. SILAS users participate in a structured exercise to evaluate the prototype version.

The exercise consisted of logging on to the computer in the regular manner students are accustomed to, going to a specific URL that contains the mapping application and completing the five steps detailed in the exercise hand out that is included as Appendix F. All student participants completed the exercise in 45 to 75 minutes.

This exercise, in general, followed the same basic steps as the Pre-prototype exercise with the addition of editing the map.

The steps consisted of the following:

- EXERCISE 1: Introduce user to the SILAS interface
- EXERCISE 2: Explore map content that has been created for SILAS
- EXERCISE 3: Learn how to modify the content and make a new map
- EXERCISE 4: Add verse citations and notes while reading scripture passages.
- EXERCISE 5: Print a map

(Benzek, 2008e)

The first step in the exercise required the participant to learn how to navigate the map, how to change scale, how to collapse and expand the layers in the “Map Contents” section, how to use the hyperlink and measure tools, and where to find help.

Participants had some problems with the map area of the screen going blank when they performed some actions (such as closing or docking a tool palette). This is a known bug

in ArcGIS Server 9.2 web applications which can be remedied if the user refreshes the web page or restarts the web browser (see Appendix F). Users seemed to tolerate the inconvenience.

During Exercise 2, one user apparently did some rapid clicking around the map application as well as some closing and opening of the web page. Each time the web application is closed without clicking on the purple “Close” button, an instance of the web service remains open for ten minutes until the limit of ten such services is reached. These actions caused the limit of the example web service “J1_Ex_Front” to be exceeded thus making it impossible for that user to proceed further. The author attempted to solve this problem by stopping and restarting the web service, but that action caused everyone’s maps to stop functioning, as should have been expected.

The solution was for all users to temporarily close their web browsers and wait about one minute for the author to stop and restart the “J1_Ex_Front” web service on the MSGIS-01 virtual server using the ArcGIS Server Manager. The number of allowable instances of the map service was increased to 20 to ensure no repeat of the problem.

Exercises 1 and 2 are the only ones in which all participants are using the same non-pooled foreground service. This is not a typical scenario since in a production configuration most users will be using their own unique SILAS web application.

Exercise 2 guides the student through turning layers on and off, understanding the symbology used in the map, and using the “Find A Place” tool in the Tasks section to locate cities and places.

There was some justified initial confusion on the part of several users because search results from the find tool are cryptic and seem to disappear when you refresh the browser. For example, the results of a search for “Nazareth” are displayed in an odd hierarchy that reflects the structure of the underlying map document (Figure 34). This makes it difficult for the user to respond to the instruction “right-click on Nazareth to zoom to that location.” (“Nazareth” with the check box is the one that will take you to the “zoom” option.)

Figure 34. Results pane from "Find a Place" task.

The results section will also collapse (its default state) when the web page is refreshed, thus giving the false impression that the "find" task did nothing.

The solution is to expand the results task by clicking the expand triangle . Part of the training should reinforce that the results are still there: they just need to be expanded to make them visible.

Exercise 3, "Learn how to modify the content and make a new map," guides the student through using the "Editor" task to add scripture citations and notes. The editor form to add a chapter and verse citation and note to the attributes of Capernaum is shown in Figure 35.

Edit Gospel Places Attributes

Gospel Places 23

Name: Capernaum

Type: City or Town

Matthew:

Mark:

Luke: 4:31

John:

GospelFlag: 1

Notes: This is my first note!

Figure 35. Editor web form showing Luke citation and note for Capernaum.

When such an edit is saved, the definition queries in the “J2_St_1” map service for the “Luke,” “My Notes” and “My Verses” layers cause the following changes in the map:

- 1) The symbol for Luke appears next to Capernaum.
- 2) The verse citation for Luke 4:31 appears, and
- 3) The note appears

The addition of the symbol and the verse citation are dependent on the student using the familiar scripture citation of verse:chapter (i.e., “4:31”).

Exercise 4 instructs students to use what they have learned by reading a scripture passage, finding the places mentioned and adding verse citations and notes. The users were encouraged to select the layers they want to display in their map and zoom to an area of interest in anticipation of the final step: printing the map.

The final Exercise has students print their map using the “Print Map” task. Every student who used the task was able to print a color copy of their map.

No one seemed to have difficulty with the print task as explained in the hand-out even though it is different than most programs: First click “Print a Map,” change the scale or DPI, add a title if desired, and then use “Print” on the new web browser window that opens.

Examples of two maps created by students during the exercise are in Figure 36.

Figure 36. Student-created maps from SILAS prototype system

The exercise was met with enthusiasm overall despite the few quirks that are most likely the result of bugs in the ArcGIS Server 9.2 web application software. Though there remain opportunities for improvement, SILAS forms a good basis for future work in creating a mapping tool for undergraduate humanities students.

4. Summary and Conclusions

The SILAS project showed that a GIS can successfully be used by undergraduate humanities students to create maps of places mentioned in Christian and Hebrew scripture. While students can perform all of the functions contained in the mandatory requirements for SILAS, the system has only begun to exploit the rich possibilities that a GIS could enable for Religious Studies students.

The project's findings range from uncovering the advantages and disadvantages of using an ArcGIS-based architecture to revealing the surprising fact that a simple set of acetate map overlays can provide important insights with minimal geospatial skills. These results will help inform future work that could be undertaken by a future MS GIS student.

4.1. Project Findings

The results of exercises at the hands of University of Redlands students form the basis of the bulk of findings and recommendations of the SILAS project. Without the enthusiasm and invaluable contributions of Dr. Larsen and her students, many more questions about using a GIS in a Religious Studies curriculum would remain unanswered.

4.1.1. Using GIS for Undergraduate Humanities Students

Using a GIS to enhance the studies and critical reading abilities of humanities students has begun to be documented (Alibrandi, 2003; Ray, 2002). In our situation, SILAS was able to be used by a variety of students who, in 2008, are generally quite computer savvy regardless of their field of study.

What was an interesting surprise was to have the general use of maps and mapping, even with old fashioned acetate layers rather than a computer, elicit sophisticated insights. This validates the use of maps and mapping tools in the humanities.

The Initial Proof of Concept test of SILAS (paragraph 3.1) showed that a complex discussion about how scholars make decisions about the authorship of historic texts can be influenced by geographic cues taken from the text. It is not clear what in the exercise served as the motivator for such a discussion, but it could have involved one or more of the following:

- Sophistication of the students
- Synergy from the group activity
- Support from a gifted professor
- Hand/eye-generated stimulus from manipulating the acetate
- Novelty of using manually applied map layers
- Focus on text and geography demanded by the exercise

A discussion of the pedagogical implications of such an exercise is out of scope of this document, but whether or not it is worth the investment learn a computer-based GIS is a

valid concern. The answer lies, in part, in the potential that a computer brings to a geographic exploration of scripture that acetate layers cannot. This potential forms the basis of future work that is proposed in a later section of this document.

4.1.2. Using GIS for Historical Applications

One of the early requirements of SILAS to represent time was ultimately set aside due to the challenge of enabling students to edit and add data rather than just viewing a neatly packaged visualization. The important temporal aspect of historic data, along with communicating to the user the inherent uncertainty in such data, have not yet been fully explored let alone implemented in SILAS. The sequence of historical events mentioned in scripture that influenced the spread of Christianity and the Jewish Diaspora, for instance, might pay large dividends in student insight were it not for the technical and data challenges.

The mechanism for displaying the temporal aspects of geospatial data is missing from the ArcGIS 9.2 web application development framework. A significant amount of software development would likely still be required to create a time slider control in an ArcGIS Server-driven Flash application, for instance. Using the full ArcMap as a client application with third-party add-ons such as Temporal Analyst (DHI Software, 2007) has more promise for a near-term means to represent time.

Even with the advent of temporal add-ons to ArcMap, the technology to fully deal with the temporal aspects of GIS data is still not available. The “Call for Participation” of the upcoming GIScience 2008 workshop “Temporal GIS: The Past 20 Years and the Next 20 Years” highlights the challenge by stating:

...while several open-source and commercial GIS packages have been developed with certain temporal capabilities, a fully functional temporal GIS still eludes us. (National Center for Geographic Information and Analysis, 2008).

Beyond the difficulty in finding a suitable mechanism to navigate the temporal aspects of historical data is 1) obtaining such data and 2) communicating its uncertainty with appropriate cartographic representation.

Certainly the dashed line can be used to represent an uncertain border, but techniques in ArcMap to fade the edges of polygons can also represent uncertainty (see Figure 37).

Figure 37. Techniques to symbolize uncertainty of regional borders, with underlying hillshade (left) and without (right).

A comparison of these two treatments of the uncertain regional borders in 1st century Palestine illustrates the challenge of communicating uncertainty in the borders while still preserving the topography of the underlying hillshade effect.

A fuller exploration of additional historical data to include in SILAS and how to symbolize the uncertainty in such data could easily be the subject of a senior or graduate-level project.

4.1.3. Using the ArcGIS Server v9.2 Suite for Web Mapping Applications

ArcGIS Server v9.2 has impressive capabilities to allow a developer to create a web application, but it requires a complicated amalgam of ASP.NET, web services, database applications and customization to implement successfully. One major problem with using this architecture is the limitations inherent in the ArcGIS web application development framework (see Table 8).

Table 8. Limitations of ArcGIS Server Web Applications

Problem	Workaround
Difficult to represent temporal aspects of data	None
No hyperlink tool	Download, install and configure third-party tool (Brenneman, 2007)
Cannot edit annotation layers	Use a label with balloon callout formatting and VBscript to handle text wrap
Maps cannot be printed	Download, install and configure third-party tool to add print function (ESRI, 2008c)
Map occasionally goes blank due to apparent software bug	User must refresh or restart web browser.
Caching is required to speed display of map services containing imagery, but user cannot selectively display fused cache layers	Place layers that need to be selectively displayed in slower, non-cached map services
Exceeding the number of available web service instances will cause a blank screen.	User waits ten minutes or an administrator stops and restarts the web service.
Results pane shows a confusing hierarchy that seems to disappear on browser refresh.	Turn off layer expand option in Visual Studio. This workaround prevents the user from turning layers off and on.
Application breaks with no feedback in Visual Studio if the developer fails to... <ul style="list-style-type: none"> - Specify the version of an SDE map layer to edit - Add an “ArcGIS Identity” for user impersonation - Specify a “local” service when configuring the editor tool - Set “application” property for the folder in Inetpub that contains the web application 	Get support from ESRI to uncover undocumented configuration requirements.
When trying to dock a floating palette, the map goes blank due to an apparent software bug.	User must refresh or restart web browser.

All of these problems have workarounds, with the exception of representing the temporal aspects of geospatial data. Together they serve as a yellow flag to future developers to use these workarounds or look for fixes in subsequent versions of ArcGIS Server.

The ArcSDE technology for editing spatial data through a web server must also be configured correctly to function in a web application. Its configuration requirements are much better documented than is the web application development framework.

The key to configuring ArcSDE correctly is to make sure folder and database permissions are set to read, write and execute for the identities that the web service manager uses on the serving computer. Details of this are well documented (ESRI, 2008a), but do require some training in SDE and Microsoft SQL Server to configure correctly. Redlands Institute IT staff performed the SDE configuration for SILAS as part of their support for the MS GIS program.

4.2. Production Version Implementation

The prototype version of SILAS is a fully functional system that could be implemented in a production configuration with little modification. What follows is an examination of three rapid implementation strategies that could quickly provide a GIS tool for students who are studying the gospels. For each implementation, recommended minor adjustments are described as well as advantages and disadvantages for each strategy and a relative measure of the implementation difficulty (see Table 9). Longer term recommendations to improve the system are described in paragraph 4.3, “Future Work.”

Table 9. SILAS rapid implementation strategies.

Strategy	Advantages and Disadvantages	Recommended Adjustments	Difficulty
1) Use web application from prototype “as is”	Advantages: <ul style="list-style-type: none"> - Uses existing interface - Web services could be consumed by ArcMap, Google Earth and other clients Disadvantages: <ul style="list-style-type: none"> - Requires server - Web application has some quirks 	<ul style="list-style-type: none"> - Password-protect individual student web applications. - Create two web sites for each student: one with scripture search and one without. 	Admin: Moderate User: Low
2) Use web services from prototype, but use ArcMap 9.2 as the client	Advantages: <ul style="list-style-type: none"> - Power of ArcMap client software - Web services could be consumed by Google Earth and other clients Disadvantages: <ul style="list-style-type: none"> - Requires server - Requires ArcMap and student training - Requires USB drive or network drive to store MXD map documents 	<ul style="list-style-type: none"> - Password-protect individual student ArcSDE databases. - Create two MXD map documents for each student: one with scripture search and one without. 	Admin: Moderate User: High
3) Use ArcMap 9.2 with stand-alone MXD map documents	Advantages: <ul style="list-style-type: none"> - No server required - Power of ArcMap client software Disadvantages: <ul style="list-style-type: none"> - Requires ArcMap and student training to use it - Requires USB drive or network drive to store MXD map documents - Scripture search not available 	<ul style="list-style-type: none"> - Create two MXD map documents for each student: one with scripture search and one without. 	Admin: Low User: High

4.2.1. Web Application Prototype “As Is”

Using the web application prototype configuration that was validated in the student exercise is certainly the least difficult implementation strategy from the student’s

perspective. The skills required to use it are captured by the exercise described in Appendix F which successfully guided students in creating and printing maps.

This strategy does require a moderate level of effort from an administrator who must migrate and maintain the author's MSGIS-01 virtual server to a production-level enterprise ArcGIS Server with ArcSDE, SQL Server and IIS. MSGIS-01 is not intended to be used in a production configuration since it is not automatically backed up nor does it have the robustness and security safeguards of a web server that could potentially have public access.

An addition to the prototype architecture in this production strategy would be to control access to the individual student's web applications through the assignment of permissions on the server. A system administrator can easily link a student's Redlands account to their SILAS web application so that they can use the same user name and password for both. A version of SILAS without the hyperlink tool and scripture search feature could also easily be created since there that feature can take the challenge out of finding cities and places in the text.

Another way to secure each students' SILAS data is to use versioning and permissions on the SDE database server. Though not fully explored in this report, SDE can be configured to operate in a multi-editor environment with controls to approve changes and even rollback to a prior version if the data become corrupted.

Finally, this option—like the second strategy in Table 9 that uses web services—can supply geospatial data to ArcMap, Google Earth or ArcGIS Explorer. The user simply needs to know the path to the SILAS service (such as “msgis-01.spatial.redlands.edu/Maps/J1_Ex_Front”).

Appendix G contains administrator's guidance for the installation and maintenance of this implementation strategy.

4.2.2. Web Services with ArcMap Client

Using web services with the ArcMap client uses exactly the same server component as the first strategy, but without the quirks of the web application. The advantage of this approach is to leverage all the power of ArcMap to add feature and image services, perform spatial analyses, and perform extensive editing (including altering symbology). The disadvantage is that students would have to use University of Redlands workstations that have ArcMap but do not have storage space to save their work. This could be addressed by using a USB or network drive, but a more serious complication concerns using ArcMap as the client.

Unfortunately, ArcMap has its own quirks and complexity that would require a significant amount of user training. Some of this training is already included in Appendix D, “SILAS Pre-prototype Exercise Hand-out,” since ArcMap was used in the pre-prototype exercise. Editing the content was not, however, covered in the exercise.

It is conceivable that students could quickly use SILAS web services in ArcMap without editing if the pedagogical focus is changed from student-created content to combining available GIS data in innovative ways. For example, in a very short time the author was able to use ArcMap, the SILAS “J1_Ex_Front” service, and a variety of background web services from ESRI’s Geography Network (ESRI, 2008d) to show temperature, precipitation, population density and satellite imagery over the area of Israel and Palestine (Figure 38). It is left to the professor to vet available GIS resources and provide an instructional framework that meets her goal to facilitate critical reading of the Christian and Hebrew texts.

Figure 38. SILAS "J1_Ex_Front" map service display in ArcMap with background services, clockwise from upper left: satellite imagery, population density, precipitation and temperature.

4.2.3. ArcMap Client without Web Services

Like the second strategy, this final rapid implementation strategy uses ArcMap but does not use any SILAS web services—essentially a production implementation of the pre-prototype exercise. It is a bare bones implementation of SILAS that forgoes any web services or scripture search feature in favor of the simplicity of a stand-alone architecture that requires no administration and can independently operate on a University of Redlands workstation.

The lack of a server component means that SILAS could be distributed and accessed by simply inserting a CD in a computer that has ArcMap. Students would still need ArcMap training as well as a place for them to save their work.

4.3. Future Work

The unmet requirements of “Table 5. Requirements Evaluation Matrix” and the findings of the student exercises can help serve as a roadmap for future work on SILAS. The prototype system shows that a modern GIS can help students critically read a historic text, but additional work is indicated in three primary areas: 1) data, 2) analysis and 3) visualization.

4.3.1. Data

Data layers available to build a map in the SILAS prototype are limited to the following:

- Elevation (hillshade)
- Selected ancient cities
- Bodies of water
- Roman roads in and around 1st century Palestine
- Boundaries of the Roman Empire
- Labels indicating regions and provinces

The client has expressed an interest in including many other data layers to help the student better uncover the landscape of early Christianity. Gathering these data, finding web services that already have them, putting them in a geodatabase, symbolizing them and serving them as new web services are all candidates for further work on SILAS.

Table 10 lists many types of data that could become part of a future SILAS. Where “temporal” is included after a description, it would be appropriate to time-tag such data for future temporal visualization and analysis.

Table 10. Data Requirements for a Future SILAS

Description
Roman roads for the entire Roman Empire (temporal)
Detailed physical geography
Population density (temporal)
Climate type (desert, marine, temperate, etc.)
Meteorological (precipitation, temperatures, etc.)
Trade routes (land and sea, including the Silk Road)
Jewish Diaspora (temporal)
Details of important historical events (temporal)
Historical maps (temporal)
Modern maps from different perspectives (Palestinian, Israeli, Western)
Locations and photographs from archaeological sites
Locations and photographs of points of interest, temples, historical structures

4.3.2. Analysis

Performing spatial and temporal analyses on historical data and on the places mentioned in Christian and Hebrew scripture holds many possibilities for a future version of SILAS. Questions about clustering of places mentioned in the Letters of Paul or the frequency of place occurrences in the different gospels are candidates for spatial analysis. Figures 39 and 40 show examples of a spatial analysis of places mentioned in the Pauline Letters and the gospels of Matthew and Mark. These cartographic representations hint at the possible GIS analyses that SILAS could provide if the appropriate tools were added. The ArcGIS Server web ADF has an established mechanism for placing analysis tools in a web application.

(Benzek, 2008a)

Figure 39. Proportional symbol map showing frequency of places mentioned in the 13 Pauline Letters.

Figure 40. Comparison of the density of places mentioned in the gospels of Matthew and Mark.

A spatiotemporal tool that could contrast the Jewish Diaspora with the spread of Christianity could have significant pedagogical value. A tool to perform a simple hot spot analysis on point data—much more achievable in the ArcMap architecture—could encourage a discussion or further study of a variety of religious, cultural and political phenomena.

4.3.3. Visualization

ArcMap is but one architecture to consider for creating maps and visualizations. The Internet boasts dozens of GIS applications and “mashup” tools for non-GIS users to create new and innovative visualizations of spatial data. Shockwave Flash, Google Earth and Microsoft’s Silverlight technology are being leveraged to create novel map visualizations that immerse the user in a way that SILAS cannot do. The David Rumsey Map Collection also uses a custom map viewer, Insight, that allows a user to look at multiple historic maps at once (Cartography Associates, 2007). Such a visualization tool could provide a means for a student to compare different cartographic treatments of maps of the Roman Empire and 1st century Palestine from different time periods and geographic origins.

The SILAS Initial Proof of Concept exercise also showed that students would like to be able to create annotations (arrows, for example) to visualize the sequence of places visited and change symbology to denote the importance of a place (is it visited or merely mentioned).

Ways to display the temporal aspects of data using animation or other immersive techniques could obviously apply to SILAS. The potential of such techniques to captivate and inspire a student are certainly worth future exploration.

4.4. Conclusions

The SILAS project showed that undergraduate religious studies students could use a GIS to do the following:

- Understand GIS concepts such as map scale and layers
- Construct their own maps using data layers of their choosing
- Annotate a map with scripture citations while reading from either prepared excerpts or a book of Hebrew and Christian scripture
- Develop sophisticated insights about the text that might not be achieved at the undergraduate level without the use of maps.

The complexity of developing the ultimate web application has exposed many strengths and weakness of the underlying ArcGIS Server architecture. If GIS support personnel are available, it is natural to pursue a production SILAS that basically mimics the prototype architecture. Without this support, the evolving on-line, freely available GIS and mashup tools may be able to be molded into a SILAS-like application that does not have the development and support burden of the ESRI architecture

The project has exposed the author to a wide-ranging spectrum of GIS tools: from data acquisition and digitization through web dissemination, cartography and database administration. It has also shown that the pedagogical issues of integrating such a system into a Religious Studies curriculum are exceedingly complex. The challenge is now in the able hands of the project client, Dr. Lillian Larsen, and project advisor Dr. Diana Sinton.

SILAS should provide a solid basis for them to further develop the concept of a GIS for the humanities. I hope they succeed and am very pleased to have played some small role in their efforts.

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Appendix A—Matthew Gospel Handout with Places Highlighted

MATTHEW

Matthew 11

20 Then he began to reproach the cities in which most of his deeds of power had been done, because they did not repent. ²¹Woe to you, **Chorazin**! Woe to you, **Bethsaida**! For if the deeds of power done in you had been done in **Tyre** and **Sidon**, they would have repented long ago in sackcloth and ashes. ²²But I tell you, on the day of judgement it will be more tolerable for **Tyre** and **Sidon** than for you. ²³And you, **Capernaum**, will you be exalted to heaven?

No, you will be brought down to Hades.

For if the deeds of power done in you had been done in Sodom, it would have remained until this day. ²⁴But I tell you that on the day of judgement it will be more tolerable for the land of Sodom than for you.'

Matthew 14

34 When they had crossed over, they came to land at **Gennesaret**. ³⁵After the people of that place recognized him, they sent word throughout the region and brought all who were sick to him, ³⁶and begged him that they might touch even the fringe of his cloak; and all who touched it were healed.

Matthew 15

21 Jesus left that place and went away to the district of **Tyre** and **Sidon**. ²²Just then a Canaanite woman from that region came out and started shouting, 'Have mercy on me, Lord, Son of David; my daughter is tormented by a demon.' ²³But he did not answer her at all. And his disciples came and urged him, saying, 'Send her away, for she keeps shouting after us.' ²⁴He answered, 'I was sent only to the lost sheep of the house of Israel.' ²⁵But she came and knelt before him, saying, 'Lord, help me.' ²⁶He answered, 'It is not fair to take the children's food and throw it to the dogs.' ²⁷She said, 'Yes, Lord, yet even the dogs eat the crumbs that fall from their masters' table.' ²⁸Then Jesus answered her, 'Woman, great is your faith! Let it be done for you as you wish.' And her daughter was healed instantly.

29 After Jesus had left that place, he passed along the **Sea of Galilee**, and he went up the mountain, where he sat down. ³⁰Great crowds came to him, bringing with them the lame, the maimed, the blind, the mute, and many others. They put them at his feet, and he cured them, ³¹so that the crowd was amazed when they saw the mute speaking, the maimed whole, the lame walking, and the blind seeing. And they praised the God of Israel.

32 Then Jesus called his disciples to him and said, 'I have compassion for the crowd, because they have been with me now for three days and have nothing to eat; and I do not want to send them away hungry, for they might faint on the way.' ³³The disciples said to him, 'Where are we to get enough bread in the desert to feed so great a crowd?' ³⁴Jesus asked them, 'How many loaves have you?' They said, 'Seven, and a few small fish.' ³⁵Then ordering the crowd to sit down on the ground, ³⁶he took the seven loaves and the fish; and after giving thanks he broke them and gave them to the disciples, and the disciples gave them to the crowds. ³⁷And all of them ate and were filled; and they took up the broken pieces left over, seven baskets full. ³⁸Those who had eaten were four thousand men, besides women and children. ³⁹After sending away the crowds, he got into the boat and went to the region of **Magadan**.

Matthew 16

13 Now when Jesus came into the district of **Caesarea Philippi**, he asked his disciples, 'Who do people say that the Son of Man is?' ¹⁴And they said, 'Some say John the Baptist, but others Elijah, and still others Jeremiah or one of the prophets.' ¹⁵He said to them, 'But who do you say that I am?' ¹⁶Simon Peter answered, 'You are the Messiah,* the Son of the living God.' ¹⁷And Jesus answered him, 'Blessed are you, Simon son of Jonah! For flesh and blood has not revealed this to you, but my Father in heaven. ¹⁸And I tell you, you are Peter,* and on this rock* I will build my church, and the gates of Hades will not prevail against it. ¹⁹I will give you the keys of the kingdom of heaven, and whatever you bind on earth will be bound in heaven, and whatever you loose on earth will be loosed in heaven.' ²⁰Then he sternly ordered the disciples not to tell anyone that he was* the Messiah.*

Matthew 17

22 As they were gathering* in **Galilee**, Jesus said to them, 'The Son of Man is going to be betrayed into human hands, ²³and they will kill him, and on the third day he will be raised.' And they were greatly distressed.

24 When they reached **Capernaum**, the collectors of the temple tax* came to Peter and said, 'Does your teacher not pay the temple tax?*' ²⁵He said, 'Yes, he does.' And when he came home, Jesus spoke of it first, asking, 'What do you think, Simon? From whom do kings of the earth take toll or tribute? From their children or from others?' ²⁶When Peter* said, 'From others', Jesus said to him, 'Then the children are free. ²⁷However, so that we do not give offence to them, go to the lake and cast a hook; take the first fish that comes up; and when you open its mouth, you will find a coin;* take that and give it to them for you and me.'

Matthew 19

19 When Jesus had finished saying these things, he left **Galilee** and went to the region of **Judea** beyond the **Jordan**. ²Large crowds followed him, and he cured them there.

³ Some Pharisees came to him, and to test him they asked, 'Is it lawful for a man to divorce his wife for any cause?' ⁴He answered, 'Have you not read that the one who made them at the beginning "made them male and female", ⁵and said, "For this reason a man shall leave his father and mother and be joined to his wife, and the two shall become one flesh"? ⁶So they are no longer two, but one flesh. Therefore what God has joined together, let no one separate.' ⁷They said to him, 'Why then did Moses command us to give a certificate of dismissal and to divorce her?' ⁸He said to them, 'It was because you were so hard-hearted that Moses allowed you to divorce your wives, but at the beginning it was not so. ⁹And I say to you, whoever divorces his wife, except for unchastity, and marries another commits adultery.*'

¹⁰ His disciples said to him, 'If such is the case of a man with his wife, it is better not to marry.' ¹¹But he said to them, 'Not everyone can accept this teaching, but only those to whom it is given. ¹²For there are eunuchs who have been so from birth, and there are eunuchs who have been made eunuchs by others, and there are eunuchs who have made themselves eunuchs for the sake of the kingdom of heaven. Let anyone accept this who can.'

Matthew 20

²⁹ As they were leaving **Jericho**, a large crowd followed him. ³⁰There were two blind men sitting by the roadside. When they heard that Jesus was passing by, they shouted, 'Lord,* have mercy on us, Son of David!' ³¹The crowd sternly ordered them to be quiet; but they shouted even more loudly, 'Have mercy on us, Lord, Son of David!' ³²Jesus stood still and called them, saying, 'What do you want me to do for you?' ³³They said to him, 'Lord, let our eyes be opened.' ³⁴Moved with compassion, Jesus touched their eyes. Immediately they regained their sight and followed him.

Matthew 21

21 When they had come near Jerusalem and had reached **Bethphage**, at the **Mount of Olives**, Jesus sent two disciples, ²saying to them, 'Go into the village ahead of you, and immediately you will find a donkey tied, and a colt with her; untie them and bring them to me. ³If anyone says anything to you, just say this, "The Lord needs them." And he will send them immediately.*'

⁴This took place to fulfil what had been spoken through the prophet, saying, ⁵Tell the daughter of Zion,
Look, your king is coming to you,
humble, and mounted on a donkey,

and on a colt, the foal of a donkey.'

⁶The disciples went and did as Jesus had directed them; ⁷they brought the donkey and the colt, and put their cloaks on them, and he sat on them. ⁸A very large crowd* spread their cloaks on the road, and others cut branches from the trees and spread them on the road. ⁹The crowds that went ahead of him and that followed were shouting,

'Hosanna to the Son of David!

Blessed is the one who comes in the name of the Lord!

Hosanna in the highest heaven!'

¹⁰When he entered Jerusalem, the whole city was in turmoil, asking, 'Who is this?' ¹¹The crowds were saying, 'This is the prophet Jesus from **Nazareth** in Galilee.'

12 Then Jesus entered the temple* and drove out all who were selling and buying in the temple, and he overturned the tables of the money-changers and the seats of those who sold doves. ¹³He said to them, 'It is written, "My house shall be called a house of prayer"; but you are making it a den of robbers.'

14 The blind and the lame came to him in the temple, and he cured them.

¹⁵But when the chief priests and the scribes saw the amazing things that he did, and heard* the children crying out in the temple, 'Hosanna to the Son of David', they became angry ¹⁶and said to him, 'Do you hear what these are saying?' Jesus said to them, 'Yes; have you never read, "Out of the mouths of infants and nursing babies you have prepared praise for yourself"?''

¹⁷He left them, went out of the city to **Bethany**, and spent the night there..

Appendix B—ESRI GIS Software Capacity QuickView

ESRI GIS Software Capacity QuickView

ESRI has many GIS tools available for education. Different tools have different capacities, and may or may not be appropriate for specific purposes. This simple table is designed to give a snapshot summary of some basic powers and key differences of popular technologies in classroom instruction. For more info, see www.esri.com/software.

	ArcWeb Explorer v.1	ArcExplorer Java Edition for Education (2.3)	ArcGIS Explorer	ArcView 9.2 (ArcGIS Desktop)
Free or \$	free	free	free	\$
Application type	uses web browser	light desktop app	light desktop app	heavy desktop app
Hard drive space required for application and built-in data	browser only	app = 100 mb data = 100 mb	app = 50 mb data = Web/cache	app = 1.2 gb data = choice
Windows 98	Y	-	-	-
Windows 2000, XP	Y	Y	Y	Y
Windows Vista	Y	-	Y	Y
Macintosh OS9	-	-	-	-
Macintosh OSX	Y	Y	(via virtual machine)	(via virtual machine)
Software extensions available	-	-	-	many
Create/save/open/distribute "projects"	share URL	Y	Y	Y
Create/edit shapefiles and attribute tables	import spreadsheet to make graphics	import XY to points	create graphic points with notes	Y
Usable image formats	ArcWeb Services	many	many	many
Display data from ArcIMS, WMS, and ArcGIS Server data servers	-	ArcIMS	ArcIMS, WMS, ArcGIS Server	ArcIMS, WMS, ArcGIS Server
Join external tables to existing data	-	-	-	Y
Integrate decimal degree vector data to match images via on-the-fly projection	-	Y	Y	Y
Integrate data from multiple coordinate systems in a single map on the fly	-	-	Y	Y
Pan, zoom, identify, find, measure, buffer	pan, zoom, find, identify graphics	Y	Y	Y
Classification and symbolization	only in data maps	20 classes, limited symbols	limited	vast and unlimited classes and symbols
Can save classification and symbolization as independent, reusable legend	-	-	-	Y
Histograms	-	Y	-	Y
Conduct spatial analyses	only in data maps	simple	via connection to server	advanced
Create charts	reports in data maps	-	-	Y
Export map contents to image formats	browser based	JPG, BMP, PNG	several	many + PDF
Create layouts	-	Y	-	Y
Method of making multiple maps visible at once	multiple application windows	multiple application windows	multiple application windows	multiple maps in a layout; child windows
Method/ease of displaying 3-D orthographic view ("spinning globe")	-	specific entry	click and drag	specific entry; 3D extension
Method of simplifying interface	widgets	3 toolbars	several sub-windows	many toolbars
Catalog application for file exploration & navigation	-	Y	-	Y
Custom curriculum (ArcLessons = www.esri.com/arcllessons)	ArcLessons	ArcLessons	ArcLessons	Mapping Our World-9, ArcLessons
For more info, see this page:	www.arcwebservices.com/awx	www.esri.com/aejee	www.esri.com/arcgisenplorer	www.esri.com/arview

Appendix C—Data Lineage and Server Paths

Feature	Lineage	Server Paths to Data (on MSGIS-01)
Boundaries	<i>Map 12, The Roman World</i> (Attridge & Meeks, 2006) scanned and digitized at 1:500,000 scale	F:\SILAS_source\ SILAS_J1.gdb\Administrative\
Large_Labels	<i>Map 12, The Roman World</i> (Attridge & Meeks, 2006) scanned and used as basis for annotation.	F:\SILAS_source\ SILAS_J1.gdb\Administrative\
Palestine_Labels	<i>Map 13, Judea, Samaria, and Surrounding Areas in New Testament Times</i> (Attridge & Meeks, 2006) scanned and used as basis for annotation.	F:\SILAS_source\ SILAS_J1.gdb\Administrative\ and msgis-01.sde.SDE
Countries	Original ESRI data reprojected to Albers Conic Equal Area Roman Empire (Albers RE) and clipped to the extent of the Roman Empire (ESRI, 2007b)	F:\SILAS_source\ SILAS_J1.gdb\Administrative\
Bodies_of_Water	Original NGDC data files unioned and clipped to create polygon visualization of bodies of water (National Geophysical Data Center (NGDC), 2008)	F:\SILAS_source\ SILAS_J1.gdb\PhysicalFeatures\
Rivers	Original ESRI data of Jordan and Nile Rivers reprojected to Albers RE and clipped to the extent of the Roman Empire (ESRI, 2007b)	F:\SILAS_source\ SILAS_J1.gdb\PhysicalFeatures\
Ancient_Places	Original points from ESRI data used as basis for locations with modifications for ancient places in accordance with the Harper Collins Study Bible and Getty Thesaurus of Geographic names. Clipped to Roman Empire and reprojected to Albers RE (Attridge & Meeks, 2006; ESRI, 2007b; Getty Research Institute, 2007)	F:\SILAS_source\ SILAS_J1.gdb\Places\ and msgis-01.sde.SDE
RE_PopPlaces	Original ESRI data reprojected to Albers RE and clipped to the extent of the Roman Empire (ESRI, 2007b)	F:\SILAS_source\ SILAS_J1.gdb\Places\
RomanRoads	Hand-digitized Roman Roads in shpfile format projected into Albers RE, derived from Barrington Atlas of the Greek and Roman World (Talbert & Bagnall, 2000)	F:\SILAS_source\ SILAS_J1.gdb\Transportation\ and msgis-01.sde.SDE
africa_150m_earthsat.jp2	Original ESRI data clipped to extent of Roman Empire (ESRI, 2007b)	F:\SILAS_source\ Auxiliary Data and Scans\global_imagery\
europe_150m_earthsat.jp2	Original ESRI data clipped to extent of Roman Empire (ESRI, 2007b)	F:\SILAS_source\ Auxiliary Data and Scans\global_imagery\

Feature	Lineage	Server Paths to Data (on MSGIS-01)
srtm_n_relief_c.jp2	Original ESRI data clipped to extent of Roman Empire (ESRI, 2007b)	F:\SILAS_source\ Auxiliary Data and Scans/
dbo.NRSV_Bible	Extracted from Bible Software on University of Redlands workstations in tab-delimited text format. Then Processed into columns in Microsoft Excel, imported into Access then imported into SQL server.	MSGIS-01.Databases.Bible
Cities_Examples and AP_Student_1 <i>through</i> 8	Original points from ESRI data used as basis for locations with modifications for ancient places in accordance with the Harper Collins Study Bible and Getty Thesaurus of Geographic names. Scripture references per Harper Collins Study Bible. Clipped to Roman Empire and reprojected to Albers RE (Attridge & Meeks, 2006; ESRI, 2007b; Getty Research Institute, 2007)	msgis-01.sde.SDE

Appendix D—SILAS Pre-prototype Hands-On Exercise Handout

Spatially Interactive Literature Analysis System (SILAS)

Hands-On Exercise

Introduction

SILAS is a Geographic Information System (GIS)-based program that will allow you to create and print maps of readings, events and places mentioned in Hebrew and Christian Scripture. These maps should help in understanding the place or “spatial” context of the narratives and accounts given in Hebrew and Christian Scripture.

SILAS uses software called “ArcMap” that was created right here in Redlands by the ESRI corporation and which is available on most computer workstations at the Jones Computer Center and other places on campus. This exercise will consist of...

EXERCISE 1: Introduce you to the ArcMap interface

EXERCISE 2: Explore map content that has been created for SILAS

EXERCISE 3: Learn how to modify the content and make a new map

EXERCISE 4: Print your map.

EXERCISE 1: Introduction to ArcMap

Log on and open an ArcMap file and save a copy

- 1.1. Log on to the computer using your University of Redlands user name (firstname_lastname) and password.
- 1.2. Locate “My Computer” on your desktop and open this file by double-clicking on it:

`C:\SILAS\SILAS_1.mxd`

It may take several minutes. This will open up a map of the world that focuses on the Roman Empire and 1st c. Palestine. You can think of it as a map that contains geographic content in the form of “layers” that you can peel away or add unlike a paper map.

- 1.3. On the File menu at the top, select Save As... and save a copy of the map in the default location “My Documents” with the name MyMap1.mxd.

Explore the ArcMap interface of MyMap.mxd

- 1.4. The figure above shows five main parts of ArcMap with a SILAS map of the area around Israel in the “Map Display” window. The red circle shows where the cursor is in miles with “0.0 0.0 Miles” exactly at Jerusalem.

Look at “Tools Toolbar” and experiment with the eight tools circled in red. These are the navigation tools:

Note that if you get lost or want to go back, you can always use the “Previous Extent” tool or “Full Extent” tool to get oriented.

- 1.5. Next look at the “Standard Toolbar” below which focuses on the “Go To...” bookmark list and the “Map Scale.”

Use Go To... to go to the Jerusalem, Galilee, Roman Empire and finally back to the Israel bookmark.

The Map Scale shows how far distances are on the Map Display. 1:3,000,000, for example, means that one-inch on the Map Display equals 3,000,000 inches (or about 47 miles). Try a different scale such as 1:10,000,000.

- 1.6. Make sure you are at a convenient scale by selecting Israel.
- 1.7. Examine the “Table of Contents” area to the left of the map. It shows groups of layers of geographic information on the map. A check in the box means the layer or group is visible.
- 1.8. Next,
 - Uncheck the ☐ boxes next to “Water” and “Terrain”
 - Click the box next to “Today’s World” to expand that groupThe Table of Contents should look like the image below:

- 1.9. Finally,
--Check the ☒ box next to “Satellite Imagery”.

Your display should look something like this:

Feel free to zoom in or out to various places or use the other navigation tools to find your way around.

Next, go on to Exercise 2.

EXERCISE 2: Explore map content that has been created for SILAS

Open file C:/SILAS/SILAS_2.mxd and save as MyMap2.mxd

- 2.1. In ArcMap, on the Main Menu go to File...Open and open C:/SILAS/SILAS_2.mxd. If prompted to save MyMap1.mxd, choose Yes if you wish to use it later.
- 2.2. Next, on the File menu at the top, select Save As... and save a copy of the map in the default location with the name MyMap2.mxd.

Examine the layers in the Table of Contents

- 2.3. To make it easier to see the symbols on the map, turn off the “Terrain” and “Today’s World” layer groups by
--Unchecking the ☐ boxes next to “Terrain” and “Today’s World”.

Your display should look something like this:

- 2.4. Next,
--Click the box next to “Ancient Cities” to expand that group.

Your Table of Contents should look like the illustration below.

“Cities from the Bible” are cities mentioned in the Hebrew and Christian Scripture while “Other Cities” are on the map for reference. Note the different symbols used for these layers:

Cities from the Bible: Jerusalem
Other Cities: Byzantium

- 2.5. Next, turn on the “Terrain” layer to add depth to the map by
--Checking the ☒ box next to “Terrain”.
- 2.6. Click on the Find tool in the Toolbar Tools to locate Byzantium and Jerusalem.

Make sure the “Feature” tab is selected as shown in the illustration below.

Type Byzantium next to “Find:” Byzantium, then click the “Find” button.

Right-click “Byzantium” in the box at the bottom and select “Zoom To.”
Your screen should look like this:

Drag the “Find” window so the map is visible to see the location of Byzantium. The map has zoomed in to show you the location of the city. Use the navigation controls to zoom out to see the nearby area.

- 2.7. Now use [Go To...](#) to go back to the Israel bookmark. Then use the Find tool as you did in Step 2.6 to locate Jerusalem. Arrange your windows so you can see the map as well as the “Find” window. This time, just click on Jerusalem in the bottom of the “Find” window to “flash” the location. A green dot appears at Jerusalem. NOTE: Try to find other cities this way.

Even though you cannot see the label due to too many other symbols near Jerusalem, you can use the “flash” feature to find it.

- 2.8. Lastly, use the Zoom-In tool to get closer to Jerusalem on the map (it is just to the left of “Bethany”).

Examine the Roman Roads layer in the Table of Contents

- 2.9. Use to go back to the Galilee bookmark.
- 2.10. Turn on the “Terrain” and “Roman Roads” layers in the Table of Contents by --Checking the ☒ boxes next to “Terrain” and “Roman Roads”
- 2.11. Expand the “Roman Roads” layer by clicking the plus sign. The Table of Contents should look like this:

NOTE: Roman Roads are shown as black lines whose thickness indicates if it is a major or minor road. Approximate locations are shown by dotted lines.

- 2.11. Use the pan or “hand” tool to move the map and follow one of the major roads south until you reach Jerusalem.

Examine other layers

- 2.12. Turn on and expand other layers in the Table of Contents to explore them. The map can easily become too congested with material to be useful unless you are zoomed in closely. [Note: The layer groups “My Gospel Places” and “Example” will be used in Exercise 3.]

Continue with Exercise 3.

EXERCISE 3: Learn how to modify the content and create a new map

Open file C:/SILAS/SILAS_3.mxd and save as MyMap3.mxd

- 3.1. In ArcMap, on the Main Menu go to File...Open and open C:/SILAS/SILAS_3.mxd. If prompted to save MyMap2.mxd, choose Yes if you wish to use it later.
- 3.2. Next, on the File menu at the top, select Save As... and save a copy of the map with the name MyMap3.mxd.

Read sections of the Gospels from a traditional book of Hebrew and Christian Scripture and add a symbol indicating the book reference.

- 3.3. Expand the “My Gospel Places” and “Luke” layers in the Table of Contents by
--Clicking the plus-sign next to “My Gospel Places” and “Luke”

Your Table of Contents should look like this:

It contains many cities and is too large to see all at once. Use the scroll bars to look at the contents. Drag the right edge of the Table of Contents to make it larger, if necessary.

- 3.4. Using Christian Scripture that is opened to the Gospel According to Luke, check the ☒ boxes next to places that occur in the text. This will add a small pink icon next to each place mentioned in Luke as shown: Zarephath
- 3.5. Repeat step 4 with other places mentioned in other gospels. Different icons display to represent the four gospels:

(Matthew) (Mark)
(Luke) (John)

- 3.6. Save your map MyMap3.mxd by selecting File...Save As...

Use the Hyperlink tool to use the “Bible Place Reference”.

- 3.7. Use to go back to the Israel bookmark.
- 3.8. Turn off the “My Gospel Places” layer and turn on the “Example” layer by --Unchecking the ☐ box next to “My Gospel Places,” and --Checking the ☒ box next to “Example”

The “Example” layer shows places in the gospel already labeled with symbols representing the reference.

- 3.9. Click on the Hyperlink tool in the Tools Toolbar shown below. This will activate blue dots where there are links to a web page.

- 3.10. Using the hyperlink tool, click on a blue dot: **Sychar** . You have to get right on the center of the dot and see the link in a yellow box before you click!

This will open up a web browser with a list of Biblical references for that city in either the Gospels or, optionally, the entire Hebrew and Christian Scripture. Explore a few cities this way and feel free to examine the references in the text.

- 3.11. Close your web browser windows and keep your ArcMap window showing SILAS_3.mxd open for Exercise 4.

EXERCISE 4: Print your map

Select the layers you want to print and print a map.

- 4.1. Go to the window containing your map `MyMap3.mxd` from the previous exercise or start over by opening `C:/SILAS/SILAS_3.mxd` from ArcMap.
- 4.2. Turn layers on and off, and zoom in or out of the map to create a map you would like to print.
- 4.3. Click on **My SILAS Map** to see a preview of your printed map. This view, known as the “Layout View” adds a North arrow, a legend explaining the symbols and a “scale bar” to show distances.
- 4.4. On the Main Menu, select `File...Print` and then click on `Setup` to choose a printer. Click `OK` twice to print.
- 4.5. To switch back to “Data View”, click on the globe:

This completes the Exercise.

Appendix E—Software Development Details for SILAS Web Application

Notes on Making the Spatially Integrated Literature Analysis System (SILAS) Pre-prototype Web Mapping Application

- 1) Make any SDE layers (point, polygon, line) that need to be editable in ArcSDE. Turn on versioning, if you like. (Arc Catalog). I turned versioning on in ArcCatalog—and it was set to the “default” user. I could not find out how to turn versioning off once it is on or learn how to assign privileges to users. This will be left to a future task.
- 2) Create an MXD with the layers. I used multiple maps since I wanted a background cached and wanted a separate map service to edit. “Caching” as set in the ArcGIS Service Manager is merely layer caching...not the more efficient fused caching.
- 3) Create map services in ArcGIS Server Manager. I made the editable layer “non-pooled” with no cache on the editable layers. This will permit editing changes to be visible immediately. For the background layer, I made it pooled and cached to speed rendering. If I wanted to do fused caching, I could set just a few zoom layers in ArcCatalog to speed drawing of the application.
- 4) Use visual studio to create a new web map site. HTTP local is a good path to use.
 - a. Defined a Map Resource Manager to be one of the map services. Use “local” as the type since I wanted to do editing. If you have multiple services, then make sure you set the appropriate transparency colors.
 - b. Since I used local, I right click the web site and add ArcGIS identity. Used Stephenbenzek, password, spatial OR create an account specifically for the web application in the AGISusers group as an identity.
 - c. Changed the magnifier and overview maps to point to the correct map resource name (default: MapResourceItem0). Magnify and overview can only be used on one service.
 - d. I wanted task areas expanded when the map opens, so for the compass rose and overview map set “Expanded” to “True”. If you want the copyright panel to display, set it to be Visible = true.
 - e. To create my editing task, I dragged the editor element to the TaskManager. Set the resource, editable layers, and version to edit. Make

sure you set an ArcGIS Identity as above. If you forget the version to edit, the application may crash the client's computer.

- f. To add the hyperlink tool, I followed the directions. I had to make sure that I had a local copy of the DLL on the server. Also make sure that it points to the correct map resource item layer and field that has a hyperlink resource (i.e., MapResourceItem0, "Name" field). This customization is in the ".vb" file associated with the hyperlink tool. NOTE: When I upgraded to SP4, the hyperlink tool did not work anymore—it simply refreshed the map. My solution was to delete it and add it again (both as a reference and in the tool bar).
 - g. I changed the style by copying a theme folder and renaming it. I replaced the images with new ones. Edited the default.skin and MapViewerStyleSheet.css files to customize the look and feel.
 - h. I wanted to add the bookmark manager that I got from Brett, but did not have time.
- 5) Some future actions to perform include:
- a. Set up caching for the background map service to speed drawing. You can do this in ArcCatalog.
 - b. Customizing the editor tool to eliminate unnecessary tools and permit editing ONLY of the data that a particular user is responsible for. This requires accessing the "user.identity" value.
 - c. Set up versioning. If you "right-click" on the database in catalogue or right-click the SDE feature, you can set versioning and privileges. This will allow multiple students to edit only their own content.
 - d. Another option is to create multiple SDE tables, each owned by a different student and then require them to login to their web site.

Steve Benzek

April 10, 2008 - GIS 664

Appendix F—SILAS Prototype Hands-On Exercise Handout

Spatially Interactive Literature Analysis System (SILAS)

Final Hands-On Exercise

Introduction

SILAS is a Geographic Information System (GIS)-based program that will allow you to create and print maps of readings, events and places mentioned in Hebrew and Christian Scripture. These maps should help in understanding the place or “spatial” context of the narratives and accounts given in Hebrew and Christian Scripture.

SILAS used special software called “ArcMap” back in March, but now only requires a web browser. This exercise will consist of...

- **EXERCISE 1:** Introduce you to the SILAS interface
- **EXERCISE 2:** Explore map content that has been created for SILAS
- **EXERCISE 3:** Learn how to modify the content and make a new map
- **EXERCISE 4:** Add verse citations and notes while reading scripture passages.
- **EXERCISE 5:** Print your map

EXERCISE 1: Introduction to SILAS

Open Internet Explorer and go to the Example SILAS web site.

- 1.1. Using your web browser, go to the SILAS web site at:

`http://msgis-01.spatial.redlands.edu/SILAS/example`

Maximize your web browser for the best view of the map.

- 1.2. It may take a few moments for the page to load. If you get a blank screen or the web page does not load at any time during this exercise, try the following:

If you have trouble...

First, click the refresh button to reload the web page.
Secondly, if that doesn't work, click on **Close** and close all browser windows. Then restart the web browser and go to the SILAS web site again.

Explore the SILAS Interface

- 1.4. The figure above shows three main parts of SILAS: Menu/Toolbar, Console and Map. The map shows the area of the **Roman Empire** as a thick green line — as well as **provinces** marked by light green lines — .

The area to the east (lower right) shows many cities in the area of Palestine that are difficult to see when you are zoomed out this far.

NOTE: If you can't see all parts of the Console, click the scroll bars at **A** and/or **B** in the diagram above..

Look at the “Toolbar” and the console section titled “Navigation.”
Experiment with the tools circled in red below by clicking and dragging on the Map:

Look at the “Toolbar” and the console section titled “Navigation.”
Experiment with the tools circled in red below by clicking and dragging on the Map. If you get a blank map or have problems, refresh the web page or close the browser and try again.

Notice as you zoom how the **Scale Bar** changes to one of 6 zoom levels:

Get back to where you were at the beginning by clicking the Full Extent tool . If the Map is blank, click the refresh button .

- 1.5. Collapse the “Tasks” and “Navigation” sections of the console by clicking the up arrow on those sections:
- 1.6. Expand the “Map Contents” section of the console to view the groups of layers of geographic information on the map by dragging the bottom of the section as shown below:

- 1.7. Examine the “Map Contents” section which shows groups of layers of geographic information on the map. A check in the box means the layer or group is visible.
- 1.8. Next,
--Click the box next to “Cities_Notes_Places” and then do the same to

“Background” to collapse those two groups. Your display should look like this:

Observe that the Map is made up of two groups of layers: “Cities_Notes_Places” are labels and markers for cities and notes and scripture references that you will add later. “Background” contains borders, roads, region labels and shaded terrain.

Experiment with turning the “Cities_Notes_Places” and “Background” groups off and on by clicking the ☒ boxes for these groups. See the “SILAS Map Symbol Guide” for a detailed explanation of map symbols.

- 1.9 Explore some of the additional links and tools on the Menu/Toolbar:

[Comments and Questions](#) | [Scripture Search](#) | [Legend](#) | [Tutorial](#) | [Help](#)

Click on [Scripture Search](#) to bring up a tool to search the entire N.R.S.V. text. You can close this window when finished, if you like.

Click on [Legend](#) to open a web page with an explanation of symbology on the map.

Clicking on [Tutorial](#) brings up this Exercise while [Help](#) provides general help on using SILAS.

Next, explore the “Measure”, “Magnify” and “Hyperlink” tools:

Click on the “Measure” tool to see how you can measure distances and areas as well as get the coordinates of a point.

The “Magnify” tool opens a small window you can drag across the map to zoom in to the “Cities_Notes_Places” group. Note that the Background is not visible in the Magnify window.

Click on the Hyperlink tool and then click on the dot next to a **Gospel Place (in BOLD)** **Zarephath**. This will search for that place in the N.R.S.V. Bible and open up a new web page with the results.

NOTE: Throughout this exercise is important to use the button when you are finished with a session or want to close the web browser. If you do not, the “service” will remain active for up to ten minutes perhaps preventing others from using the web site.

Next, go on to Exercise 2.

EXERCISE 2: Explore map content that has been created for SILAS

Open Internet Explorer and go to the Example SILAS web site.

- 2.1. If your web browser is not already there, go to:

`http://msgis-01.spatial.redlands.edu/SILAS/example`

- 2.2. It may take a few moments for the page to load. If you get a blank screen or the web page does not load at any time during this exercise, try the following:

If you have trouble...

First, click the refresh button to reload the web page.

Secondly, if that doesn't work, click on **Close** and close all browser windows. Then restart the web browser and go to the SILAS web site again.

Examine the layers in the Map Contents

- 2.3. Zoom in to the cluster of colored diamonds on the east (right) side of the map by using the zoom tool .

Turn off the following layers in the “Map Contents” section by unchecking the ☒ boxes:

My Notes
My Verses
Mark
Luke
John

Your display should look something like this:

Note the labeling conventions used in the map:

Zarephath	Place mentioned in Gospels
S Y R I A	Region
<i>Calasa</i>	Reference place
<i>Mount Carmel</i>	Peak

- 2.4. **One by one, click the empty check boxes next to “Mark,” “Luke” and “John” until they are all on and observe how the markers are distributed.** It may take a few moments for the web page to appear after each mouse click.
- 2.5. Move around the map using two different ways.
Click anywhere on the “Compass Rose” showing N, S, E and W and see how the map moves:

Next, use the Pan tool to drag the map around.

- 2.6. Gradually zoom out by using the scroll wheel on your mouse. You can also use the tool to zoom out.

- 2.7. Now go back to the full extent of the Roman Empire by clicking on .

Using the “Find a Place” Task

- 2.8. Places mentioned in the four Gospels can be quickly located using the “Find a Place” task. Expand the “Tasks” section, if necessary, by clicking on the triangle and then click on “Find a Place.”

You will use the “Find a Place” tool to locate Nazareth.

- 2.9. Click on the “Find a Place” task and then type in “Nazareth” in the search field. Click “Find”:

Note: The place must be spelled correctly to find it. Portions of a word such as “Naz” will also match.

Close the Find pop-up by click on so you can see the results of the search.

The “Results” section of the console is organized by search term (Nazareth) and then by the layer that it was found in.

Expand the Results by clicking on all of the plus signs . Then check the empty box next to “Nazareth” under “Gospel Places.” Your Results should look like this:

Notice that the verses that Nazareth appears in are listed under the city name and that they spill over to the right in the Results section. Checking the box next to “Nazareth” also puts a tiny pushpin symbol on the map 📌 next to its location.

- 2.10 To get a better look at Nazareth, right-click on “Nazareth” under “Gospel Places”, in the Results section and then select “Pan to” as in the figure below:

While this moves the map so that Nazareth is in the center, it is not easy to pick out. **Now right-click Nazareth again, but choose “Zoom To.”** You should now see Nazareth clearly.

- 2.11 Now, use the “Find a Place” tool to locate and Zoom to “Sidon” just as you did Nazareth (**Find A Place** , then Zoom to). Notice that the result box keeps adding places as you find them.

To remove the “Nazareth” results, right click Nazareth and choose “Remove” as shown below: Do the same for Sidon.

- 2.12 Click on the **Close** button in the upper right hand corner of your web browser window and close the window if prompted to do so.

NOTE: It is important to use the **Close** button when you are finished with a session. If you do not, the “service” will remain active for up to ten minutes perhaps preventing others from using the web site.

Continue with Exercise 3.

EXERCISE 3: Learn how to modify the content and create a new map

Open Internet Explorer and go to your own editable SILAS web site

3.1. Using your web browser, go to your editable SILAS web site at:

http://msgis-01.spatial.redlands.edu/SILAS/student____

3.2. If you get a blank screen, try refreshing the web page or use the other hints in Exercise 1, Step 1.2.

Add verse citations, notes and marker icons to the map.

3.3. The general procedure for adding your own notes and Gospel citations to SILAS is as follows: (The exercise will walk you through this process in part 3.4.)

How to Add Notes and Scriptures Citations to the Map

- 1) Locate the *place* mentioned in Scripture by using the “Find A Place” task)

- 2) Start the “Editor” task.

- 3) Select the place by clicking on it with the editor “Select Feature(s)” tool.

- 4) Add your notes and chapter and verse references.

5) Save your edits.

3.4 In this example of adding notes and citations to the map, assume you are reading Luke 4:31 and want to add information about Capernaum using the procedure from 3.3.

1) Locate Capernaum using the “Find a Place” task:

Close the Find pop-up by click on so you can see the results of the search.

Expand the Results by clicking on all of the plus signs . Then right-click Capernaum and select “Zoom To”:

2) Click the “Editor” task to bring up the editor window:

3) Use the “Select Feature(s)” tool to click on the point representing Capernaum. Your display should look like the figure on the right below:

- 4) Add the appropriate chapter and verse citation next to “Luke” and any notes like the figure below:

- 5) Save your work by clicking on the “Save Edit(s) tool .

Close the Editor by clicking on and wait for the map to reload to see your changes. The map should look something like this:

3.5. Your map shows three things that happened when you added the Luke verse citation and note to “Capernaum:”

1) The symbol for Luke appeared next to Capernaum.

2) The verse citation for Luke 4:31 appeared, and

3) The note appeared

The map can get very congested with these labels and symbols. **Turn off the “My Notes” and “My Verses” layers as well as “Roman Roads” by unchecking the boxes .** You can also turn off the entire Background group. This results in a simpler map that can show more of your notes and symbols.

EXERCISE 4: Read a Scripture Passage and Add the Information to the Map

Repeat Exercise 3 but instead use a Scripture passage of your choice. Add verse citations and notes and then turn layers on and off and zoom and pan. When you are ready, go on to Exercise 5 to print your map.

EXERCISE 5: Print your map

Select the Map Contents layers you want, zoom to the area of interest, and print a map.

- 5.1. Zoom into the map you created in Exercise 4 to get the content that you want to print. Turn layers on and off as desired.
- 5.2. In the “Tasks” section of the console, click on “Print Map”:

The map should go blank while a pop-up called “Print Map” appears. If you don’t see it, make sure you have any pop-up blocker turned off and try again.

Your screen should look like this:

Accept the defaults and click on “Create Print Page.”

Another web browser window should open and display your map something like this:

- 5.3 Click on the print button or type “Ctrl + P” and print as you would any web page.
- 5.4. Next, close the “Map” print window and return to your original SILAS web page. Close the “Print Map” window by clicking the button. Note that the “Results” section still has the print task visible. You can right-click on it to remove or execute it again:

5.5 Click the close button **Close** to end your SILAS map session.

This completes the Exercise.

Appendix G—SILAS Administrator’s Guide

The Spatially Interactive Literature Analysis System (SILAS) is a GIS-based study tool to allow students to integrate historical data, edit and annotate geospatial content, and create and print maps. SILAS examines GIS technologies, usability issues and how text and geography can be integrated in a single visualization. Initially focused on the spatial and temporal universe of the four gospels in the New Testament, SILAS can serve as a template for incorporating other texts, Christian and otherwise.

This guide describes the steps necessary to install SILAS on a web server. The `SILAS_Files` DVD is required to install all necessary the data and all associated files.

System Requirements (Server)

Hardware

Hardware should be consistent with requirements for ArcGIS Server v9.2. See ESRI web site for further details: <http://wikis.esri.com/wiki/display/ag93bsr/ArcGIS+Server>:

Software

ArcGIS Server with SDE Technology

ArcGIS Server 9.3 (including ArcSDE for Microsoft SQL Server) should be installed per the installation instructions from the manufacturer. The standard installation used by the MS GIS program is adequate.

ArcGIS Desktop v9.2

Includes ArcMap v9.2 is required to create and manage map services and ArcCatalog v9.2 is required to manage map services and create SDE versions of feature classes..

ArcGIS Desktop SDK for the Microsoft .NET Framework v9.2

Required to develop and manage .NET ArcGIS Server applications.

ArcCatalog v9.2

ArcCatalog v9.2 is required to manage map services and create SDE versions of feature classes.

Microsoft Windows Server

Version 2003 with service pack 2 (including Internet Information Server) was used to create SILAS. Other later versions may work as well.

Microsoft SQL Server 2005

Microsoft SQL Server 2005 with the following components and versions was used in the SILAS final acceptance test. Other later versions may work as well:

Microsoft SQL Server Management Studio: 9.00.1399.00
Microsoft Analysis Services Client Tools: 2005.090.1399.00

Microsoft Data Access Components (MDAC): 2000.086.3959.00 (srv03_sp2_rtm.070216-1710)
Microsoft MSXML: 2.6 3.0 4.0 6.0
Microsoft Internet Explorer: 7.0.5730.13
Microsoft .NET Framework: 2.0.50727.1433
Operating System : 5.2.3790

Microsoft .NET Framework

Microsoft .NET Framework 2.0, Service Pack 1, and 3.0, Service Pack 1.:

Microsoft Visual Studio 2005 Professional Edition

Required to build and configure the SILAS web application:

Installation

Copy Map Documents, Geodatabase and Imagery Files

Using `SILAS_Files` DVD, copy all files from `SILAS_source` folder to `C:\SILAS_source` on the server. This requires approximately 3.3 GBytes.

Create SILAS Scripture Search Application

1. Using the `SILAS_Files` DVD, copy all files from `SILAS2` folder to `C:\Inetpub\wwwroot\SILAS2` on the server. This requires approximately 125 kBytes.
2. In the Computer Management window, right-click the `SILAS2` folder in the default web site, click “Properties...” and “Create” an application.
3. Using SQL Server Management Studio, import the `NRSV_Bible` table from MS Access database `Bible1.mdb` on the `SILAS_Files` DVD and call the new database “Bible”.
4. Test the scripture search web page by visiting this URL:
`http://[server name]/SILAS2/search.aspx`

Create ArcSDE Geodatabases

- Using ArcCatalog, drag and drop the following files from C:\SILAS_source\SILAS_J1.gdb to the Server Database Connection and rename the databases as described in the table:

SILAS_J1.gdb Source File	Server SDE Destination Database
Places.Cities Example	sde.SDE.Cities Example
Places.Ancient Places	sde.SDE.Ancient Places
Places.Ancient Places	sde.SDE.AP Student 1
Places.Ancient Places	sde.SDE.AP Student 2
Places.Ancient Places	. . .
Places.Ancient Places	sde.SDE.AP Student 8
Administrative.Palestine_Labels	sde.SDE.Palestine_Labels
Transportation.RomanRoads	sde.SDE.RomanRoads

This will create enough web applications for eight students. If more students need to be accommodated, continue creating additional copies.

NOTE: If you want to be able to access these services using ArcMap 9.2 as the client application in addition to using the web mapping application, you must right-click the SDE database in ArcCatalog and turn on “versioning.”

Create Map Services

Using The ArcGIS Server Manager, create the following map services with the parameters indicated:

C:\SILAS_source file	Map Service	Parameters
J2_back_web.mxd	Maps\J2_back	Max Instances: 10 IsPooled: True
J1_front_all.mxd	Maps\J1_Ex_Front	Max Instances: 20 IsPooled: False
J2_front_St_1.mxd	Maps\J2_St_1	Max Instances: 4 IsPooled: False
J2_front_St_2.mxd	Maps\J2_St_2	Max Instances: 4 IsPooled: False
. . .	. . .	Max Instances: 4 IsPooled: False
J2_front_St_8.mxd	Maps\J2_St_8	Max Instances: 4 IsPooled: False

The “J2_back” map service requires a cache to be created using ArcCatalog. To create the cache, right click the J2_back service under “GIS Servers.[servername](admin).Maps.J2_back” and select “Service Properties...” Under the “Caching” tab, click “Generate...” then create a cache with the following scales:

25000000
10000000
3000000
2000000
1000000
500000
250000

Accept the defaults for the other parameters. The cache may take up to 36 hours to create. Any map services may NOT be available while the cache is being created. This cache, though not required, will greatly accelerate the speed of SILAS.

Create Web Mapping Applications

1. Using the SILAS_Files DVD, copy all files from SILAS folder to C:\Inetpub\wwwroot\SILAS on the server. This requires approximately 15 Mbytes.
2. For each file in the table below, add an “ArcGIS Identity” using Visual Studio that uses an account and password that has permissions to read, write and execute files on the server.
3. Using Visual Studio, you must edit the “MapResourceManager” web control in each of the web mapping applications to point to the correct map services. Use the settings described in the table below:

File to Edit in C:\Inetpub\wwwroot\SILAS\	Resources Setting for Cities_Notes_Places	Resources Setting for Background
Example\Default.aspx	(default)@Maps/J1_Ex_Front	Map Layers@ Maps/J2_back_web
Student1\Default.aspx	(default)@Maps/J2_St_1	Map Layers@ Maps/J2_back_web
Student2\Default.aspx	(default)@Maps/J2_St_3	Map Layers@ Maps/J2_back_web
. . .	. . .	Map Layers@ Maps/J2_back_web
Student8\Default.aspx	(default)@Maps/J2_St_8	Map Layers@ Maps/J2_back_web

4. The following three tasks in the “TaskManager” should not require editing, but the correct settings are shown for reference:

EditorTask1:

Resource to Edit—Map: Map1; Resource: Cities_Notes_Places

Select Editable Layers—Gospel Places

SearchAttributesTask1:

Choose Task Results container—TaskResults1

Choose Search Fields—see diagram below

PrintTask_VBNet1:

Choose Task Results container—TaskResults1

5. If the Print Task does not function correctly, re-install it per the instructions in the following file on the SILAS_Files DVD:

Common_PrintTask\Common_PrintTask_Readme.doc

The code for this task was originally downloaded from:

http://edndoc.esri.com/arcobjects/9.2/NET_Server_Doc/developer/samples/Web_Applications/Common_PrintTask/18425b7d-4b61-4d87-b2d2-4919b29c78f4.htm

6. If the hyperlink tool does not function correctly, re-install it per the instructions in the following file on the SILAS_Files DVD:

HyperlinkToolv2.1\Readme.doc

The hyperlink tool was originally downloaded from:

<http://arcscripsts.esri.com/details.asp?dbid=15059>

NOTE: The originally downloaded hyperlink tool does not work with ArcGIS Server v9.2 SP4. A separate version for SP4 is located on the DVD in the following location:

HyperLink Tool for SP4\

Test the Web Mapping Applications

1. Use either Internet Explorer 6 or 7 or Firefox 2.0 or later to test the web mapping application. The following URL will show the example web mapping service showing all cities and places mentioned in the four gospels:

`http://[server name]/silas/example/default.aspx`

2. If the application does not work, contact either the author or ESRI for assistance.