REVIEW OF EARLY STORAGE MEDIA DEGRADATION FACTORS, PRESERVATION TECHNIQUES AND TRENDS IN ETHIOPIA

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ABSTRACT

Since the invention of the Gramophone by Thomas Edison in 1877 society has used different storage media to record and store sound as important aspect of human life. Continued preservation of these data for the generation to come has been regarded as important goal of archivist and libraries. However, since analog storage media are not permanent, these storage media are under risk of degradation and damage. As a result, several preservation techniques and guidelines have been prepared and applied to prolong the shelve life of these analog storage media. These preservation techniques slow down the rate of degradation; they do not stop or reverse it. As a result, the long-term solution is the digitization of these recordings and copying them into the newest format whenever there is a format change. A review of degradation factors affecting storage media, preservation techniques, digital preservation guidelines and current preservation techniques employed in Ethiopia are presented in this paper. From the review, it has been observed that even though there are some institutions in Ethiopia that have understood the problem of degradation and have taken actions to decrease its effect, some institutions have not taken proper analog and digital preservation actions. As a result, the statuses of their archives are not known and significant portions of their archives are expected to be degraded.

Keywords*: Early sound recordings, wax cylinder, graphophone disc, magnetic tape, Ethiopian broadcasting corporation, Institute of Ethiopian Studies*

INTRODUCTION

Thomas Edison was the first that successfully recorded sound that could be played back in 1877 by recording human voice on a tinfoil wrapped around a cylinder. Since then recorded sound has been an important aspect of human life. Now music can be heard at home privately and it became possible to hear the same "performance" multiple times. With the invention of sound recording, educators could bring sound recordings in classroom to aid the teaching-learning process. Another important aspect of recorded sound is the preservation of oral culture. Folklore and ethnographic collections "provide audio windows into a range of cultures and geographical areas. Perhaps no other sound medium has conveyed to listeners so much history and culture, through music, diverse entertainment programming, daily news and public affairs, and interviews" [1].

A survey conducted by Heritage Preservation Inc. in partnership with the U.S. Institute of Museum and Library Services of public institutions estimated that there are around 46 million individual recordings in these institutions of which 44% of audio collections in their library were in "unknown condition" [1]. The Music Archive of the Ethnological Museum (Germany) houses 354-cylinder collections with approximately 16,800 recordings on slightly over 30,000 cylinders and approximately 3,500 magnetic tapes.

The condition of the recordings is not well known [2]. The British Library estimates that of the 6.5 million sound recordings in

its archive, 1 million of them are in risk of disappearing [3].

According to [4], the history of electronic media in Ethiopia starts with the first provisional radio station in 1933 by an Italian Company. To the author's knowledge, the most important audio-visual libraries in Ethiopia are the Ethiopian Broadcasting Corporation (EBC) audio-video library, National Library of Ethiopia, and the Institute of Ethiopian Studies (IES) library of Addis Ababa University. It is difficult to obtain literature on the status of storage media in these Ethiopian audio-video Libraries. This may stem from lack of understanding of the risks facing storage media, lack of funding or lack of experienced staff that can undertake the task of preservation.

These audio recordings are stored in different audio libraries and museums in different parts of the world. Several types of storage media have been used according to advances in technology and demands of the market. A brief chronology of recorded formats commonly found in libraries, sound archives and private collections is as follows [1].

- 1889: Wax Cylinder
- 1893: Flat disc
- 1902: Black-Wax Cylinder
- 1940: Wire magnetic recorders
- 1948: Magnetic tape
- 1948: Flat Discs of PVC
- 1958: Stereophonic LP discs
- 1964: Compact Cassette tape
- 1982: Digital recorded compact discs
- 1990: Recordable compact disc

The stored data in these storage media is faced with two important and unavoidable problems: deterioration due to 'natural aging and improper storage environment', and format obsolescence. Therefore, libraries and archivists are faced with the task of copying these contents into a more permanent media. Tasks that need to be taken by libraries and archivists are preservation, digitization, and restoration [5].

Even though the long-term solution to these set of problems is digitizing the archives and storing it in the latest format, most estimates agree that institutions have only a small window of time in which to complete high-quality digitization depending on storage conditions, the storage media used and other factors [6].

To get a clear picture of the problem facing these storage media in Ethiopia, literature review and library survey were conducted. The literature review and library survey when presented together are hoped to shed light on the current Ethiopian audio-video archive risks in a single setting.

LITERATURE REVIEW

The literature review focuses on research that was conducted worldwide related to storage media degradation, analog preservation and digital preservation. Its aim is to review degradation factors for each storage media and state of the art preservation techniques. It will be used to assess the progress done in Ethiopia.

Library Survey: In the library survey, audio-video libraries in Ethiopia were surveyed to assess the status of the stored media and preservation techniques employed. Oral interviews and library visits were conducted to assess the libraries. The results of these observations are then compared to the degradation factors and state of the art preservation techniques that are obtained in the literature review.

The literature review showed the significant risk of archived media. Even though the library survey conducted is only done in two institutions, by analyzing its findings from the literature review it showed status of the two possible extremes of audiovisual libraries on efforts made to preserve the data stored in the storage media.

The paper has been organized in five sections as follows. Section 1 briefly discusses the problem and methodology to be used. Section 2 discusses the storage media that have been used in the past century from the point of view of their principle of operation and degradation factors. Section 3 discusses the different preservation techniques that have been used and applied for the different storage media. Section 4 discuss the findings of assessment of EBC library and IES library on the status of archived media in Ethiopia. Finally, Section 5 concludes the paper by briefly discussing the implication of each of the chapter and stating what needs to be done in the future and the current state of archived media in Ethiopia.

Storage Media Employed

Of the different media that have been used, the cylinder, flat disc, magnetic tape and compact disc have the most of historical, cultural, entertainment and other data [1]. This is expected to be the case for audiovisual media stored in Ethiopian libraries and archives. Of these, the compact disc is the most recent and stable. A recent study on accelerated aging test of compact disc has reported the average life expectancy of the compact disc under room temperature and controlled humidity to be 776 years [7]. Therefore, only the cylinder, flat disc and magnetic tape are considered under significant risk and this review focuses only on these storage media.

Phonograph Cylinder

Phonograph cylinders, classified as a mechanical carrier, are the earliest commercial medium used for recording and reproducing sound [8]. Sound, which is a function of air pressure variation was captured by a horn that moves a membrane which was connected to a cutting stylus [9]. The stylus then carves these movements into the surface of a rotating cylinder. Playback worked in the opposite way – a stylus was moved by the carved groove, moving the membrane. The vibrations are then amplified by the horn.

Cylinders may be divided into the following types and their degradation is also affected to a different degree.

Brown-Wax Cylinders

Brown wax is a "metallic soap," combined with natural waxes. This material is soft enough to make a direct recording [10]. Playback of any wax cylinders at a temperature exceeding 25°C should be absolutely avoided as wear may increase significantly with temperature [10]. In addition, rapid temperature changes may cause hairline cracks and total loss of a record [10]. Because of their highly organic composition, they are unfortunately prone to fungus attack. Humidity and temperature significantly increase the rate of fungus infection. Often, they are found in an unplayable condition because of this fungus damage [10].

Black-Wax Cylinders

Black-Wax cylinders are made from metal soaps (lead stearate) with carbon and additional hardening agents [10]. The main advantage of black-wax cylinders over brown-wax cylinder is that they can be mass produced by molding process [11]. Another advantage is that black-wax records can be played at higher speed than most brown-wax records. Therefore, they are louder and capable of better sound quality [10]. Black-wax cylinder is more brittle, and becomes more so with age as compared to brown-wax cylinder. Similar to brown-wax cylinder they are prone to microorganism damage.

Celluloid Cylinders

Celluloid Cylinders were made from plaster core with celluloid plastic playback surface layer. Some of the advantages of celluloid records over wax records are: they are rarely broken by mishandling, they are durable and can be played repeatedly with

less wear than wax records and they are resistant to fungus infection [9].

Camphor, a plasticizer in the celluloid, evaporates over time causing the celluloid tube to shrink in length and diameter. If the celluloid cylinder is constrained by a core, this can cause tears in the celluloid called "end splits" [10]. Low temperature can be a high risk of breakage, as the celluloid will become significantly more brittle [9]. Another problem is that core materials (plaster and cardboard) can swell with moisture and age. This may prevent the cylinder from fitting on the phonograph mandrel [9].

Flat Discs

A gramophone record, commonly known as a disc, is a mechanical sound storage medium in the form of a disc with an inscribed spiral groove. Its principle of storage is by physically plotting the waveform of the audio signal on a disc [8]. The sound is collected by a horn that moves a diaphragm, which vibrates the cutting stylus. The resulting groove shape will be physical image of the movement of the stylus.

Discs may be divided into the following types and their degradation is also affected to a different degree.

Acetate Disk

Instantaneous recordings were usually made on acetate discs until this medium was supplanted for this purpose by magnetic tape. A lacquer coating, consisting of cellulose nitrate, carries the information. The substrate or support of the discs is usually made from metal or glass [8].

Unfortunately, cellulose nitrate is an unstable material. The most important degradation reactions are thermal, photo-oxidative, and hydrolytic decomposition which result in chain scission or reduction of molecular size. This results in delamination and cracking of the lacquer coating. Castor oil is used as a softener to provide the physical properties needed for engraving the disk. The loss of castor oil causes shrinkage of the lacquer coating [12]. Because the coating is bonded to the core and cannot shrink, the result is the creation of internal stresses which result in cracking and peeling of the coating [12]. Acetate discs are also affected by mold [13].

Shellac Discs

The shellac type disc is made of 70 percent or more of a mineral or cellulosic aggregate which is bound together and protected by resins and waxes as fillers [13]. The nature of the binder and fillers is important in determining the physical properties and response to aging of these discs, but these qualities are more dependent on the other constituents than on the binder [12]. As a result, it is quite difficult to determine the causes of shellac degradation. While the shellac is fungus resistant, the organic materials in the aggregates are susceptible to fungus attack.

The curing process during shellac manufacturing generates a condensation reaction between its organic compounds [5]. This reaction causes the shellac to shrink overtime, increasing its density and brittleness. This condensation continues at a much slower rate and this is the primary degenerative force [5]. In storage these discs suffer a slow, progressive embrittlement of the shellac [5]. Due to this a fine powder is shed from the disc after each playback.

Vinyl Discs

Vinyl discs are made of polyvinyl chloride (PVC) and a small percentage of "fillers", stabilizer, pigment, anti-static substances, etc. [5]. The vinyl disc has been observed to be the most stable of the materials used in the manufacture of discs. However, its life is not indefinite. According to [14], no systemic degradation of these materials is expected in the near future. However, PVC

degrades chemically when exposed to ultraviolet light or to heat [11]. Vinyl discs are prone to mechanical damage as they are relatively soft compared with shellac discs.

Magnetic Tapes

From its invention in Germany in 1935 and its rise to the primary medium for sound recording worldwide, magnetic tape has earned a reputation as a reliable and high-quality storage medium [15]. The recording mechanism relies on a magnetic layer, binder, capable of 'storing' the sound by retaining the magnetism impressed on them by the recording head. This layer is supported by the base film, which provides structural support [12].

The shelve life of magnetic tape is dependent on the formulation of magnetic tape which is prone to degradation in storage due to several factors; such as: type of magnetic tape, acidity, humidity and temperature of the storage environment. These factors affect the binder and base differently.

Magnetic Tape Binder

Some of the factors that affect audio quality, tapes aging properties, tape-to-head contact and noise level are, binder chemical composition, uniformity and smoothness of application [6]. The most common binder resin used is polyester polyurethane. The most common ferromagnetic particle used is gamma ferric oxide (Fe_30_2) [5]. According to [6], two major binder coating failure modes are the following.

Sticky shed syndrome (SSS): The binder resin, which is made of ester, reacts with water from humidity to release carboxylic acid and alcohol. This results in the binder shedding a gummy and tacky material which causes tape layers to stick together [16]. This degradation is sometimes temporarily treated with incubation or baking.

Loss of lubricant (LoL): It is "the failure of a tape with sticky shed syndrome to be restored to playability after a normal incubation or baking cycle" [6]. It has been recommended by Richard L. Hess [6] that this terminology be properly referred as **"**Soft Binder Syndrome (SBS)" as the cause of the failure is not really a loss of lubricant. Playback is accompanied by squealing and the tape sticks to the fixed surfaces that it may stop the playback.

Shedding and possible detachment is also observed due to hydrolysis. It causes a weakening in the bond holding the binder to the base [16].

Magnetic Tape Base

The base, the structural support of the tape, must cope with stresses imposed by playback and storage without becoming permanently deformed, or losing dimensional stability. The base film consists of, in historical sequence, acetate cellulose, PVC and polyester terephthalate, generally called polyester, which has been in use since the late 1950s [17].

The following are some common degradation effects that involve the mechanics of the physical tape [6].

Country laning: a tape deformation in which the tape does not lie straight but, rather, is wavy. This is usually the result of bad slitting during manufacture or by a poor wind.

Winding defects: "introduced by sloppy winding, the tape can have popped strands, have a portion of the pack slip, or be jammed against a flange" [18].

Edge frilling: "Tapes can frill or lose chips of oxide or base film at the edges of the tape. This seems to be caused by mechanical damage or possibly heat damage during storage or playback" [18].

Storage at high temperature and/or relative humidity levels may lead to fungus infection [17].

Acetate: Acetate tape is generally robust and it breaks cleanly rather than stretching significantly prior to breaking when overstressed. These tapes rely heavily on plasticizer additives for flexibility that evaporate and crystallize over time. This results in brittleness and drying. Acetate tapes are prone to linear expansion in the presence of warm conditions or humidity. Due to the different properties of the binder and base, humidity and heat cause in tape curling and edge fluttering [5]. High temperature, high humidity levels, the presence of iron oxide and the lack of ventilation lead to vinegar syndrome, which occurs as acetate decomposes and forms acetic acid [17]. Once it has started it can only be slowed down, not reversed [17]. This is usually observed in tapes stored in metallic containers.

Polyester: Polyester came into use in the early 1960s, and it quickly replaced acetate for magnetic tape backing [17]. Accelerated aging tests have found polyester to be a stable material. This is due to the fact that it undergoes hydrolysis degradation at a much slower rate than the binder, polyester polyurethane [19]. However, polyester-based tape has a high tensile strength that can cause it to stretch irreparably instead of breaking cleanly. Such stretched tape can't be repaired as easily as acetate-backed tape which breaks cleanly [19].

Preservation Methods

Preservation, as defined by [5], is "all actions taken to retard deterioration of, or to prevent damage to, cultural property. Preservation involves controlling the environment and conditions of use, and may include treatment to maintain a cultural property, as nearly as possible, in an unchanging state." Since audiovisual recordings are stored on storage media that cannot retain the data on them permanently, digitization and continued copying of the digital files is necessary to ensure the long-time survival of the recordings [14]. The tasks that should be undertaken by archivist and libraries to preserve the media can fall into either of the following categories [14].

Improvement of methods to identify and treat endangered media, Improvement of methods and material to decrease the rate of degradation, and Digital preservation

Identification of Endangered Media

There are different factors determining the life expectancy of a media. Some of the factors are storage media type, age, and storage history. It is reasonable to expect any older recording to be in a more risk of degradation and information loss than a recent one. Even though this assumption holds in most cases, other factors should also be considered. For magnetic tape, age by itself is not considered a major concern by archivists and preservation engineers [17]. Those that experience problems are usually plagued by issues unrelated to the aging process by itself. Such issues are storage in metallic container in the presence of high temperature and humidity leading to sticky-shed syndrome or improper handling before storage leading to winding defects, laning and others. Considering its longest age, it is straightforward to deduce that the wax-cylinder is the most endangered media of the three media formats [12]. The reason for this can be fast degradation with age, instability of the material used and format obsolescence,

Considering the significant impact of humidity and temperature on the degradation of almost all storage medium, it is reasonable to expect a recording stored in an environment with reliable climate control to be in a better condition than a recording that is stored in uncontrolled environment. As such, the presence of the humidity, temperature, magnetic fields, light and dust in the storage history is important identifier of a recording in risk [12].

Methods to Decrease the Rate of Degradation

To decrease the rate of degradation, the storage environment should be controlled to avoid degradation risks. Audio collections should be stored in locations with the following conditions.

Reliable climate control: Audio recordings should be kept at a low temperature and humidity. However, magnetic tape should not be stored below 8°C, and no audio format should be stored at or below freezing temperatures [11]. For long-term storage it is recommended between 8–12°C and 25–35% percent relative humidity

Good ventilation: to filter out any dust and foreign matter that may accumulate.

Sufficient floor loading capacity: to avoid any physical damage to the medium due to structural damage of the storage shelve.

Fire suppression systems Security Recordings should also be protected against damage from light and magnetic fields.

Light: materials made of PVC are susceptible to degradation in the presence of light especially UV light. Magnetic fields: magnetic fields may disrupt magnetic audio recordings.

Digital Audio Preservation

Any medium used for sound recording will deteriorate overtime. The process of preservation using analog video tape was through analog migration which is not an exact copy. Digital preservation via high-quality digital audio files makes subsequent copies produced by digital migrations bit-for-bit identical with their predecessors. This makes digital migration retain the quality of the original digital recording. However, there are some risks in digital preservation and migration: bits can be lost during storage or when files are migrated [1]. These risks can be mitigated by good data-management practices such as read/write error reporting via error detection and correction coding.

Preserving digital audio recordings requires the active maintenance of the recordings. The Technical Committee of the International Association of Sound and Audiovisual Archives (IASA) has published two guides to audio preservation, "TC-04" [20]. These guidelines, have become the benchmark of digital audio preservation best practices. Even though there are still issues that remain to be resolved and gaps to be bridged within the audio preservation community, there is agreement in principle on the following seven points [1].

Digital storage medium is the preferred medium of preservation. Analog formats degrade over time – both physically and sonically – even if they are stored under ideal conditions of temperature and humidity. IN addition, analog formats cannot be copied without signal loss and some additional of noise.

Digital audio files should be transparent, i.e., audibly indistinguishable from the original. Linear pulse code modulation (PCM) file format is the preferred encoding method. It is the standard form of digital audio in CDs, computers, digital telephony and other digital audio applications.

Preservation transfers must be flat without any equalization of the frequency range or use of restoration techniques. Flat digital files contain the most information that may be used for restoration or post preservation reprocessing in the future, especially when improved restoration approaches are developed.

Digital audio preservation files must be recorded at high sampling and bit rates, and without any compression. Though there is no consensus on the exact sampling and bit rates, they should be selected as the largest value the digitizer and storage space allows.

Storage must be planned for the long term. Long-term preservation requires the

migration of digital files over time and creation of digital-repositories. The last 130 years of audio archival experience shows us that they get more precious they older they get.

Rich metadata related to content, format, and other attributes of the audio files must accompany preservation files. Without systematic collection of structured information of the audio files it will be quite difficult if not impossible to use them after some time where there may be change of personnel, organizational structure and other factors.

Professionalism is an essential component of audio preservation. The continuous training of staff to the latest techniques should be considered as a critical part of digital preservation.

Ethiopian Context

From the discussion thus far, it is clear that all storage media that have been used worldwide are under significant risk of degradation and total loss of the data stored. This is also true for the case of storage media used in Ethiopia. As such, the storage history and preservation efforts that are implemented in audio-video libraries in Ethiopia, in combination with the degradation risks reviewed, can shed light on the status of the archived audiovisual history of the country.

To understand the current condition of the storage media in Ethiopia, EBC library and IES library were selected for assessment. The libraries were visited to assess their facility in terms of types of storage media, type of data, preservation efforts, assessment methods, and ongoing digitation efforts. A brief finding on the visit has been categorized into types of storage media employed, storage history and current preservation efforts

Ethiopian Broadcasting Corporation

1. Types of Storage Media

The audio-video media in EBC library are stored in magnetic tape, CD/DVD or flash memory. None of the data was stored in phonograph cylinder or flat disc formats, as magnetic tape was the dominant storage media format when the corporation started operation. Of these media, only the magnetic tape is in significant risk of degradation.

2. Storage History

The storage age of the recordings ranges from few months to 70 years. The following were observed about the audio-video library.

The recordings are well documented and catalogued. This is in line with one of the most important principles of archival – metadata management is a critical part of archival.

The storage media are stored in cardboard boxes and plastic boxes. No recordings were stored in a metallic container that would increase the risk of degradation of magnetic tape. This is observed to have increased the shelf life of the magnetic tape – sticky shed syndrome has been avoided.

Analog migration has been conducted periodically. Even though analog migration is not a perfect migration, it has considerably increased the shelf life of the magnetic tape storage media. In addition, even though there is a significant age difference on when they were recorded, the periodic analog migration has made them much closer in storage age.

The audio/video library does not have air conditioning. However, considering the average temperature and humidity in Addis Ababa is 16.3^0C and 60.7% respectively [21], the absence of air conditioning doesn't pose a significant degradation risk. For continued storage of these recordings, the

usage of climate control should be considered.

The audio-video library does not have air filters. This poses degradation risk as the library is adjacent a main road. Fumes and dust particles from vehicles may cause accelerated degradation as discussed in section 2. For prolonged storage and preservation, the use of air filters should be considered.

Current Preservation Techniques Used

For continued usage, preservation and to aid in easy access, EBC is digitizing all the media in its libraries. There are 35 thousand hours of analog video data and 82 years' worth of audio/radio broadcast data. The radio and video digitation are carried out separately. The digitization efforts and their alignment with international guidelines on digital preservation are discussed below.

Audio/Radio

All the radio broadcast analog media data has been digitized and ingested to a central digital archive along with important metadata.

Even though there is a metadata management system implemented, it is not comprehensive. The management of metadata should be considered seriously as it is a critical part of archival.

The digital files are stored in WAV format without compression. The WAV format uses linear PCM which is in line with IASA guidelines.

Most of the analog media were in a good condition and as a result most of the digital audio files have good quality. However, there are very few recordings that could not be digitized due to significant degradation and format obsolescence. It was not possible to obtain the exact figure of those that were degraded. In addition, there are some recordings which have low quality due to degradation. Further investigation and restoration efforts should be considered on the recordings that were too degraded to be digitized.

Video/TV

Of the 35 thousand hours of video data in the audio-video library 11 thousand hours has been digitized and ingested into the digital archive. The remaining video data is in the process of digitization.

Similar to the audio/radio archival, the metadata management system is not comprehensive. The management of metadata should be considered seriously as it is a critical part of archival.

The video is stored in MXF format using encoders to change different file formats, flv, avi, mp3, mp4 and others. Encoding and compression techniques that are used in archiving should be carefully considered as changes in technology may render the data unreadable.

There are some video recordings that are degraded and were difficult to read and digitize. It was not possible to obtain the exact figure of those that were degraded. Restoration efforts should be considered on these recordings.

There are some recordings that couldn't be digitized because of format obsolescence. More efforts in obtaining spare parts or new professional equipment that can play these recordings should be investigated.

Institute of Ethiopian Studies (IES)

IES inherited its audio-video library from Emperor Haile Selassie I, as such the some of the audio-video media are as old as almost 100 years old.

Types of Storage Media

The audio-video media in IES library are stored in Phonograph Cylinder, Flat Disc and Magnetic Tape (Open-reel, 35 mm video film, High 8 film, VHS, Mini DV, Unidentified magnetic tape media). The

storage media in its archival are more susceptible to degradation as compared to EBC as they are older. Furthermore, considering they have been in storage for as far as a century ago, all the storage media are under significant risk of degradation.

Storage History

The following were observed about the library where the audio-video media were stored.

The recordings are not well documented and catalogued. It is not possible to distinguish which of the recordings are in which format. As such, it is quite difficult and time taking to identify endangered media which is the first step in any preservation effort.

The storage media are not stored systematically. The storage media are scattered in different rooms and the storage history in each of these rooms is not well documented. This makes determination of quality of the recordings and identifying degradation risk very difficult.

No analog or digital migration have been conducted. Furthermore, the recordings have not been copied to newer media periodically to retain their quality.

The main audio-video library has air conditioning. However, not all rooms where the audio-video recordings are located have air conditioning. For continued storage of these recordings, the usage climate should be considered.

None of the libraries have air filters. The main library is cleaned frequently and there was no noticeable dust on the shelves. However, the other rooms where the audio-video recordings are located are not cleaned frequently. As a result, the recordings in these rooms are in significant risk of degradation and air filtering should be considered in the future.

Current Preservation Efforts

The audio video media have not been digitized. The media are stored in their original storage media. Considering their age and uncontrolled environment they are stored in, the audio-video media are in great risk of damage. It is anticipated that most of the recordings have some if not significant amount of degradation. The quality and extent of degradation of the media is not known at this time.

IES is in pre-digitization. It is identifying the following factors that should be investigated before digitization. Preservation efforts are being carried out currently.

Conclusion and further work

Over the past 140 years, humanity has stored vast amounts of sound recording in different types of storage media. Degradation factors on each of the storage media have been reviewed. None of the media are permanent and are under risk of degradation and data loss. Several preservation techniques and guidelines that increase the shelve life of these media have been reviewed. These preservation techniques merely decrease the rate of degradation; they do not stop or reverse it. As time goes by, the impact of these degradation will be significant even if the best preservation techniques are applied.

The storage history and preservation techniques used in Ethiopia have been reviewed. Even though the library survey conducted is not comprehensive, it shows status of the two possible extremes of audiovisual libraries on efforts made to preserve the data stored in the storage media. Considering the age of some of these recordings and the lack of systematic preservation techniques applied in some libraries, it is expected that there are significant number of recordings in libraries and archives that have been degraded.

This was observed in EBC audio-video library where some recordings were significantly degraded and data could not be read. Efforts in restoring these recordings are therefore very important to access the vast amounts of data in these recordings.

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